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IN THIS ISSUE: SUBMARINE ENGINES OF THE WORLD'S NAVIES

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MOTORSHIP

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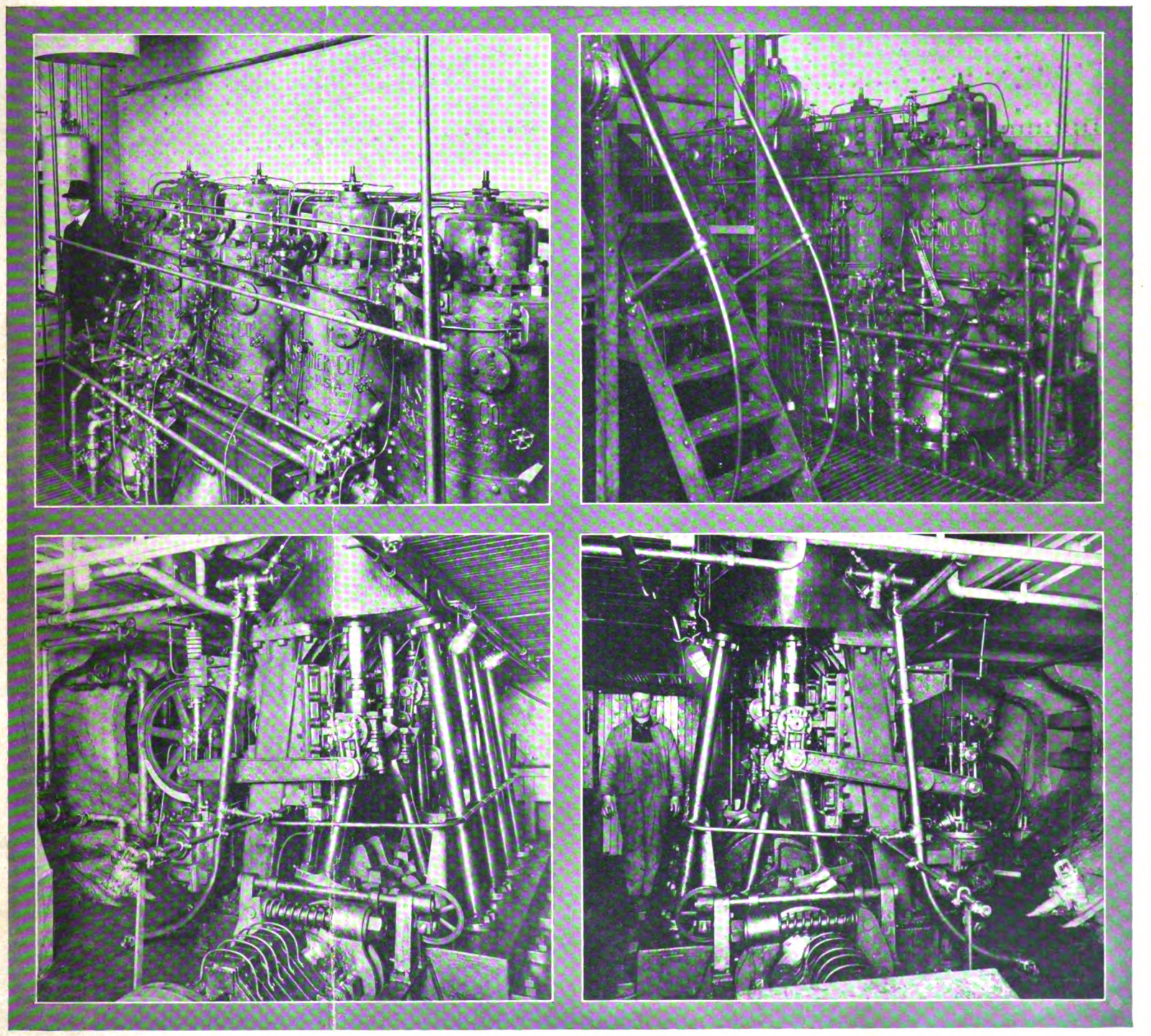
In the Interests of Commercial Motor Vessels

Vol. 2 APRIL, 1917 No. 4
SEATTLE NEW YORK



SUMNER OIL ENGINES IN M. SC. "SANTINO"

Views Show Both Port and Starboard Engines Above and Below the Gratings.

(See Page 11.)

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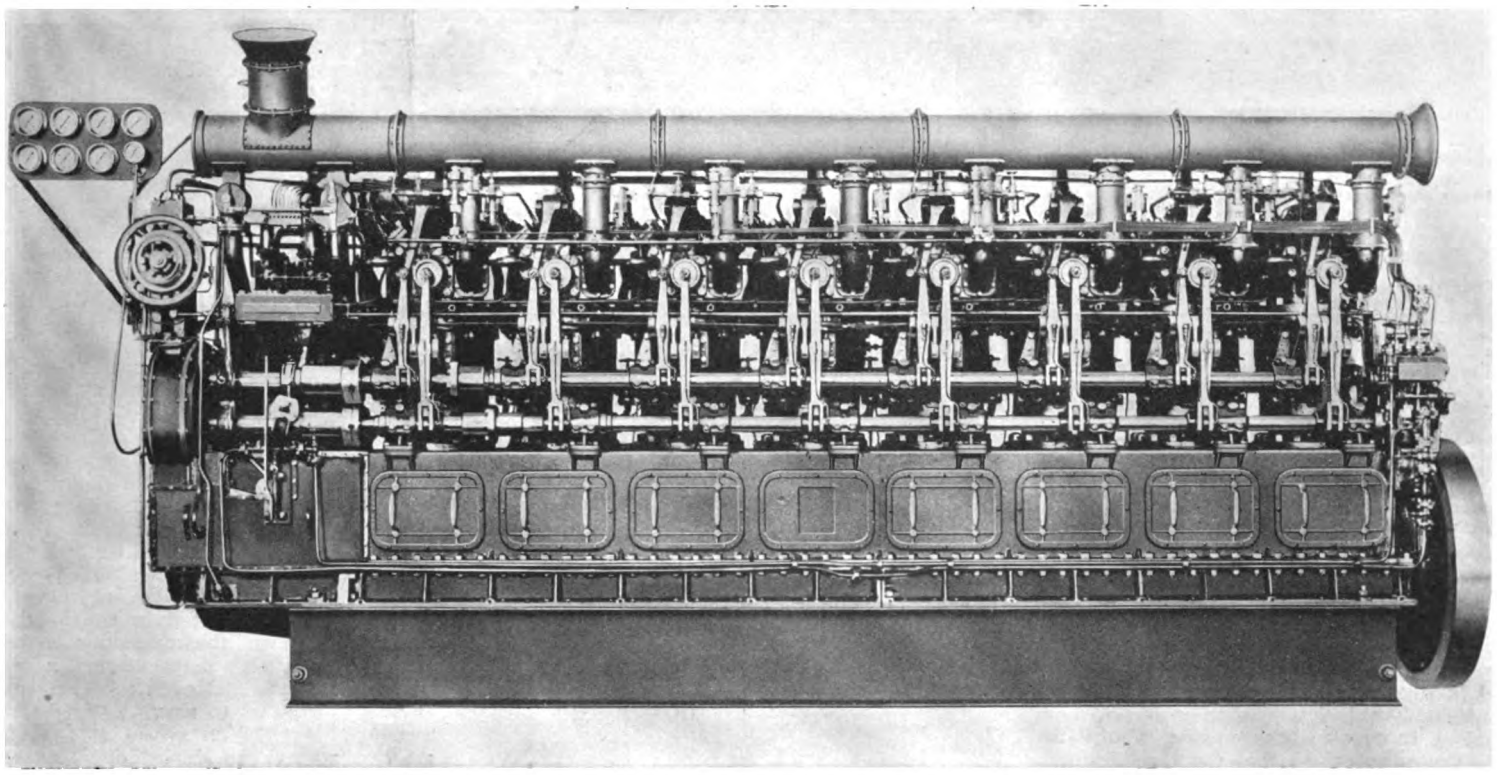

THE NLSECO 600 B. H. P. SUBMARINE ENGINE—THESE MACHINES HAVE EQUIPPED MOST OF THE UNITED STATES' SUBMARINES (See Page 9).

Submarine Diesel-Type Engines of the World's Navies

By T. ORCHARD LISLE

Written Specially for Motorship

TODAY the submarine is the most discussed class of vessel ever built and no other method of obstructing navigation of the seas has been so vital in upsetting the world's commerce as the submarine attack. For, as an "unseen destructor" of merchant ships the submarine has shown itself to be unequalled, and its victim gets but little chance of escape. There can be no doubt that without her fleet of submarines Germany's present position would have been very critical, because considerably over a million tons of supplies for the Allies (apart from supplies for neutrals) have been sent to the bottom and irretrievably lost. These supplies, had they been safely delivered, would materially have strengthened the Allies' military and financial position. The loss must have been enormous. For that much Germany openly relies upon her submarine commerce-destroying campaign to enable her to dictate peace terms advantageously to herself.

Before the days of the submersible war-vessel, blockade runners relied upon speed to elude the cordon of watching warships, and were it not for the existence of nearly three hundred British and French submarines it is fully on the cards that Germany would have built a fleet of fast freight carriers—ships as fast, or faster, than the swiftest of the Allied cruisers. Germany, however, no doubt fully realizes that because the speediest of Britain's liners fall easy victims to her watchful U-boats the same would be the case with any surface blockade-runners that she (Germany) could build, because all the Allies together have over 400 submarines.

Without the heavy-oil internal-combustion-engine the submarine still would be practical, because steam or gasoline can be, and has been adopted with reasonable results; but, certainly Germany never could have maintained such an extensive U-boat warfare as she has done during the last two years, because the cruising radius of any other type of submarine would be far too limited and the operations less reliable, hence it would not have been possible for the U-boats to cruise so far from their bases and remain so long at sea. In other words, Germany would have needed three to four times as many submarines as she actually has had in service.

To put it plainly, Germany's chance of victory is due to a German invention, namely, the Diesel oil-engine. Once peace reigns Germany would do well to create a suitable monument to the memory of the late Dr. Rudolf Diesel, although were he alive he probably would strongly object to anything of such a nature because of the inhuman work for which his invention unfortunately has been used. Dr. Diesel was essentially a German, but there was little of the Prussian military spirit in him, for, like most scientists, he was essentially a man of peace and the warlike spirit is totally absent from his nature. That his sovereign never honored him with a title or degree was a bitter disappointment and gives considerable cause for wonder. The honorary degree of "Doctor" was conferred upon him by the University of Munich. The greatest honor Dr. Diesel ever received in his lifetime was the conferring of the Gold Medal of the Franklin Institute, a grant very rarely conferred. Curiously enough Herr Lauster, a clever German engineer who was responsible for making the genius of Dr. Diesel practical, also never was honored by the Kaiser, unless it has been done since the war.

Just as has been the case with the mercantile-type of the Diesel engine, the submarine-type Diesel engine has made greater progress and more extensive development in Europe than it has in this country, with the result that all the warring nations have larger, faster, and more effective submarines than has the U. S. Navy, and this being the case, a review of the various European and American submarine Diesel-type engines will be of particular interest at this time. Of course, it is not possible to give drawings and details of the machinery of craft laid down since hostilities commenced; but in many cases we are enabled to give illustrations and particulars of engines of boats that were building, or had just been completed, at the outbreak of war, so that they apply to many submarines now in use, and closely indicate the lines now being followed with later and larger craft.

GERMANY.

Germany having made the greater use of her submersible craft, the engines of her boats rank first in importance, because of being in the limelight as it were, so we will deal with them first. The majority of Diesel engines installed in her submarines were built by Fried. Krupps, of Kiel-Gaarden, and by the Augsburg Works of the Maschinenfabrik-Augsburg-Nürnburg, better known as the M. A. N. engines. A couple of sets of engines for submersible craft were built at the Nürnburg Works of the M. A. N.; but the author understands that their services did not warrant the German Admiralty placing further orders; but confined their attention to the Augsburg Works of the same company, who were building a different design and cycle. One or two other concerns, including Körting Bros., built some moderately powered sets.

The KRUPP. Krupps spent a fortune in indeavoring to produce a successful two-cycle Diesel submarine engine, and found it best to construct the cylinders, crank cases and cylinder-heads of a special phosphor-bronze and a very expensive engine was the result. If the words of the chief-engineer of the Deutschland can be accepted Krupps now are devoting their attention to the four-cycle engine, and consequently have been enabled to revert to the cast-iron construction. The shortage of copper probably made this an absolute necessity.

Krupps first produced their 900-1,000 b. h. p. two-cycle submarine Diesel engine in the latter part of 1910, and, although they rate it as 850 h. p. at 425 r. p. m., this motor develops 1,050 b. h. p. maximum on a weight of 18 tons, and it seems incredible that here we are in the year 1917 the largest Diesel engine in a completed American submarine is only of 600 b. h. p., or 1,200 b. h. p. for a twin-screw boat. This design of Krupp engine was still being built up to the outbreak of hostilities, and we presume that with modifications, and also in larger sizes, the design has been followed right up to the time of changing to the four-cycle principle.

This engine (Fig. 1) is very neat in design and shows considerable designing skill on the part of Herr Regenbogen, the Chief Diesel Engineer of Krupp's Works, at Kiel, each motor being built in two units of three cylinders each, and a scav-enging-pump (475 mm. bore) with the cam driving-shaft and air-compressors arranged in the center,—that is to say, be-

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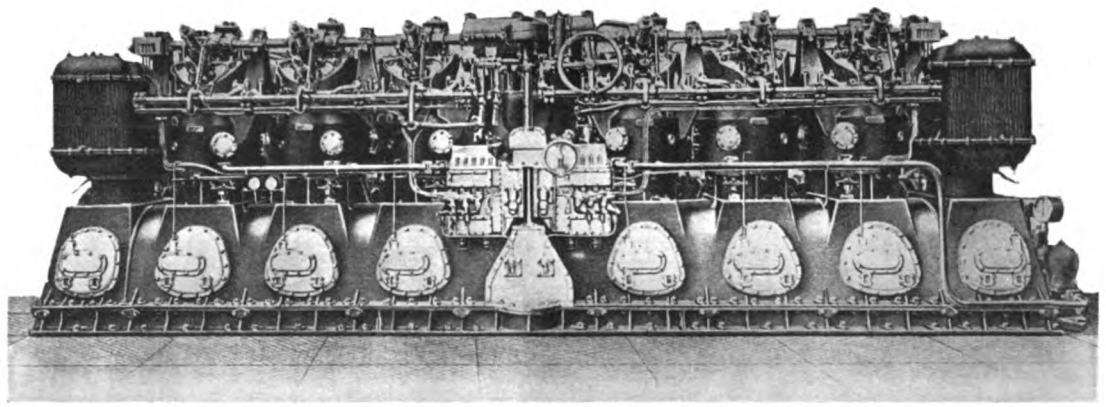

FIG. 1.—KRUPP TWO-CYCLE SUBMARINE ENGINE. 825 B. H. P. AT 425 R. P. M.

tween the two groups of cylinders. The cylinder-heads follow the Krupp stationary engine practice, and have inclined tops into which the fuel-injection and air-starting valves are set at an angle, and operated by rockers off the camshaft, which, by the way, is in two sections. The cylinders have a bore of 350 mm. (13.7 in.) by 400 mm. (15.7 in.) stroke, and the engine normally turns at 400 r. p. m. No crossheads or guides have been adopted, and the pistons are of the trunk design, which arrangement makes the height of the engine very low for its power, and the latter is an important feature of a submarine engine. But the engine is not very accessible as the cylinder heads and gear have to be dismantled when it is desired to remove a piston. Scavenging is by the port system. Two of these engines were fitted in many of the Krupp U-class boats, and in view of the fact that seven years have elapsed since the first 1,000 b. h. p. engine was completed they have had ample time in which to increase the size and power of this engine, and it is not at all improbable that the engines of latest submarines are of 2,000 b. h. p. each, or 4,000 b. h. p. per boat, which would give the larger submersibles of the U-class a speed of about 20-21 knots. Some of the Krupp submarines were supplied to Norway and to Russia. U2 to U16 are submarines of much smaller power.

The NURNBURG. The Nürnburg two-cycle engine, (Fig. 1a), which was installed in a couple of U-class boats of the same size as those in which the Krupp engine was fitted is illustrated. To a measure this engine is of considerable importance as it also has been supplied to many other navies, also it is from the Nürnberg designs that the New London Ship & Engine company has been building during the last half-a-dozen years, but I understand that the latter company lately have produced their own four-cycle design and have abandoned the German design. The Nürnberg engine illustrated is of 900 b. h. p. in eight cylinders, 300 mm. (12 in.) bore by 340 mm. (13.3 in.) stroke at 450 r. p. m., and in outward appearance is one of the neatest looking submarine motors ever built. It is of the single-acting type with stepped-pistons, and control is by a single hand-wheel at the after end of the engine. So far as I can trace the first set of this design and power was completed at the beginning of 1913; but it was not so successful as the Augsburg and Krupp engines.

The AUGSBURG. The Augsburg engine, also an M. A. N. production, differs from the Nürnburg motor, being of the four-cycle box-frame type, and it has been one of the most successful of Diesel engines employed by the German navy, and the quality of workmanship perhaps never has been excelled. Like the Nürnburg motor, it has the single-wheel control with the various controlling mechanisms interlocked. The 850-900 b. h. p. model is in six cylinders, 400 mm. (15.7 in.) bore by 400 mm. (15.7 in.) stroke, and develops its power at 450 r. p. m., and has a considerable overload. A characteristic feature is the covering of the valve rockers and cams by means of neat metal guards. The success of this engine largely was due to the conservatism and skill of Herr Lauster, the engineer who assisted Dr. Diesel to develop the Diesel cycle to a commercial form.

GREAT BRITAIN.

About the British submarines very little is known owing—until recent years—to the construction being entirely in the hands of one concern, namely, Vickers, Ltd., who, having no competitors, did not have to seek publicity, so were enabled to maintain strict technical secrecy. But the 1912 class of British submarines were said to be of 1,200 tons and required two Diesel engines of about 1,200 b. h. p. each to propel them. Quite formidable craft for those days so the present-day boats undoubtedly are much larger. The British navy have ten small submarines recently built by the Fall River Shipbuilding Co., and engined by the New London Ship & Engine Co., of Groton, Conn.

The VICKERS. In the early days of the adoption of the Diesel engine for submarines, Vickers, Ltd., (who previously had fitted Wolseley gasoline and kerosene motors) in conjunction with Carels, of Ghent, produced a two-cycle engine not unlike the Krupp in appearance. The construction of this design, however, was abandoned, I understand, some years ago, and Vickers produced an eight-cylinder four-cycle Diesel-type engine of 850 b. h. p., of their own design, for which Mr. James McKechnie,

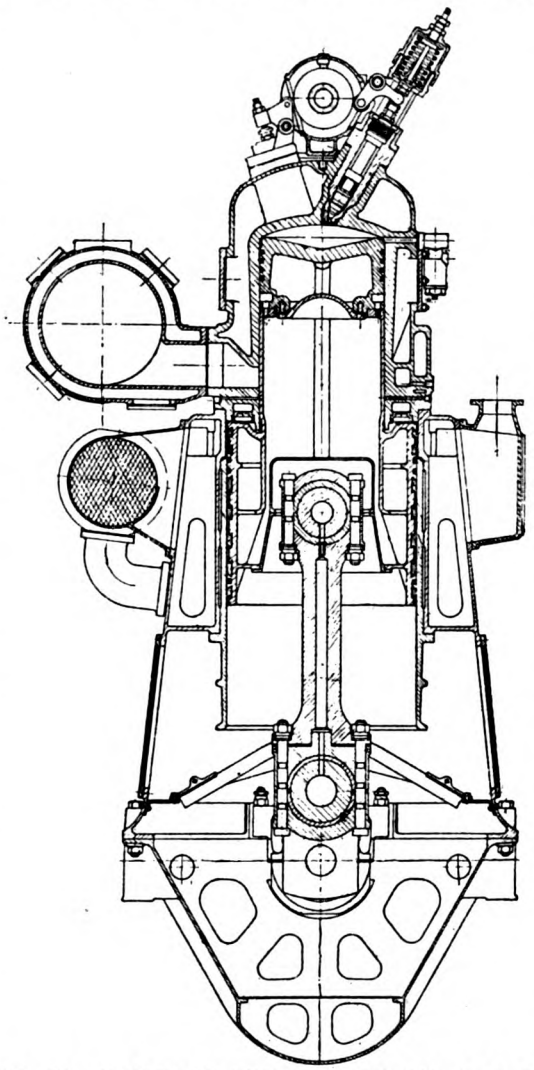

FIG. 1A.—SECTION OF THE NURNBURG 900 B. H. P. TWO-CYCLE SUBMARINE ENGINE.

their technical-director, mainly was responsible. In this engine injection of fuel by means of a powerful spring operated pump, or injector, was tried with the idea of simplifying the engine by dispensing with compressed-air injection, and I believe that this is retained, so accurately speaking the Vickers engine is not of the true Diesel cycle.

The latest Vickers submarine engines are of very high power and, unlike the engine of any other navy, are in twelve cylinders, and the power developed per engine is not far short of 2,000 b. h. p., or about 4,000 b. h. p. per boat in 24 cylinders.

The SCOTT—F. I. A. T. A few years ago the Scott Shipbuilding Co. commenced submarine construction for the British government, and acquired a license from the F. I. A. T. Co., of Turin, Italy. It was intended to lay down a submersible of 5,000 h. p., but it was realized that this was high power for Diesel motors, and the plans were changed to steam turbines. Whether this boat is successful or not, is not known outside of the builders, and of the Admiralty.

FRANCE.

It is not generally known that France has two submarines of about 5,000 i. h. p. in service. One is the "Gustave Zede," a 1,000-ton boat, in which steam turbines of 5,000 i. h. p. are fitted in conjunction with reduction-gearing and the other is the "Nereide." Eight torpedo tubes are fitted to the first named and she is a swift and formidable war vessel, but her cruising radius is limited to 2,300 miles, or about half of the radius of the modern Diesel-engined submarines. France first went in for gasoline submarines, then steam, then Diesel engines, then steam again, only to again adopt Diesel motors, and today she is using both. Her Diesel-driven craft should be the most highly developed of all submersibles, because many of greatest engineering concerns are engaged in this branch of naval constructional work, including, Schneider & Co., Augustin Normand & Co., and the Sabathé Co., also she has used Nürnburg, Krupp, Augsburg, and Sulzer Diesels in her submarines, so the French navy has had exceptional experience and certainly have not lacked enterprise or development energy. In fact, France was the first navy to use the Diesel engine in her submarines.

The SCHNEIDER. In addition to this 5,000 i. h. p. steam-driven submarine, the French navy is believed to have a Diesel-driven submersible of 1,700 tons displacement in which are said to be installed two 6,000 h. p. Schneider Diesel engines; but I am strongly inclined to doubt this and believe that Messrs. Schneider, when they told me, intended to convey that the total power was 6,000 indicated-horse-power, or about 4,500 brake-horse-power per boat, which would be about the right power to give a 1,700-ton vessel a speed in the neighborhood of 20 knots. With the extensive experiences at Messrs. Schneider's disposal such a vessel should be quite feasible and even moderately successful. Hence, it is safer to assume that this giant submarine is a 1,700-ton vessel of 4,500 b. h. p., or in other words, the ideal fleet-submarine that the U. S. A. Navy Department is seeking to have built.

Now the submarine "Nereide," which they built, bears out my remarks, because this vessel has two eight-cylinder Diesel motors of the two-cycle type, 18½ ins. bore, and of 2,400 b. h. p. each, at 350 r. p. m. This gives 4,800 b. h. p. total power. The "Nereide" probably is the highest-powered Diesel-driven submarine in the world.

Schneider & Co., of La Creusot, have been building both four-cycle and two-cycle type submarine Diesel engines. At the middle of 1914 they had under construction no fewer than 20 Diesel engines of the two-cycle type aggregating 20,900 b. h. p., and 16 Diesel engines of the four-cycle class aggregating 6,980 b. h. p., or a total of 27,860 b. h. p. This gives an average of 770 b. h. p. per engine for the 36 motors. This is apart from mercantile sets. Previous to this they had completed about 30 submarines and their machinery.

As regards the technical details of their engines, the description by M. Drosne, the chief engineer of Schneider & Co., may be of interest. "All the Schneider engines for submarines, whether four-stroke cycle, are extra light. They are vertical, single-acting, with trunk pistons. The bedplates and frames are of cast steel; the cylinders, which are either separate or cast with the frames, are of cast-iron, or cast-steel with cast-iron liners. The cylinder-cover is of cast-steel, and carries (for four-stroke cycle engines) the inlet-valve, the exhaust-valve, the fuel-injection-valve, and starting-valve. For two-stroke cycle engines the air-inlet and exhaust-outlet valves are replaced by scavenging-valves. All parts exposed to heat, such as the cylinders, cylinder-covers, exhaust-valves, or ports, are practically the same as for heavy mercantile-type engines, except that for the latter the bedplates, frames, and cylinders are of cast-iron, and that the pistons are provided with rods and crossheads.

"The drawing (Fig. 2) shows the cross-section of a cylinder of a Schneider 510 h. p. eight-cylinder four-stroke-cycle Diesel engine. The fuel-valve casing is fitted at the bottom with a ball pulveriser and multiple-hole diffuser. The ball pulveriser distributes the fuel in a very uniform manner with the air that is injected, though it offers but little resistance to the passage of that air owing to the balls being round. On the other hand, the multiple-hole diffuser allows the mixture to be sent in the required direction to distribute it evenly in the compression chamber, thus preventing it from being injected on to any one part that might get injured.

"One fuel-pump is provided for each cylinder, and each oil-pump is regulated by varying the amount of lift of its suction-valve, and the special features of the gear for giving this variation are as follows: (1) Hand regulation; (2) regulation from the manoeuvering camshaft; (3) regulation by over speed. The hand regulator, which works on a quadrant, serves to regulate the speed or load on the engine. The regulation from the manoeuvering shaft comes into play when starting ahead or astern, so that the pumps begin to work at the right moment only. Lastly, the speed limit device acts so as to prevent racing.

"The pistons are in two parts, joined together by long bolts, in which tubes carrying the cooling-oil work telescopically. The piston-head carries segments in cast-iron, or steel, which bear lightly against the central part of the body of the piston. The telescopic tubes are provided at the bottom with a swivel joint, leaving them free to move in any direction, and maintaining a proper oil tightness. The hot oil is returned from the piston to a filter, whence it is pumped by a special pump through a tubular cooler and back into the pistons."

I am enabled to include the average results of a series of tests made with one of the large Schneider-Diesel engines made in 1914. This was an eight-cylinder, single-acting, two-cycle reversible model, 13 in. bore by 14.5 in. stroke, and the consumption is little over half-pound per b. h. p. hour.

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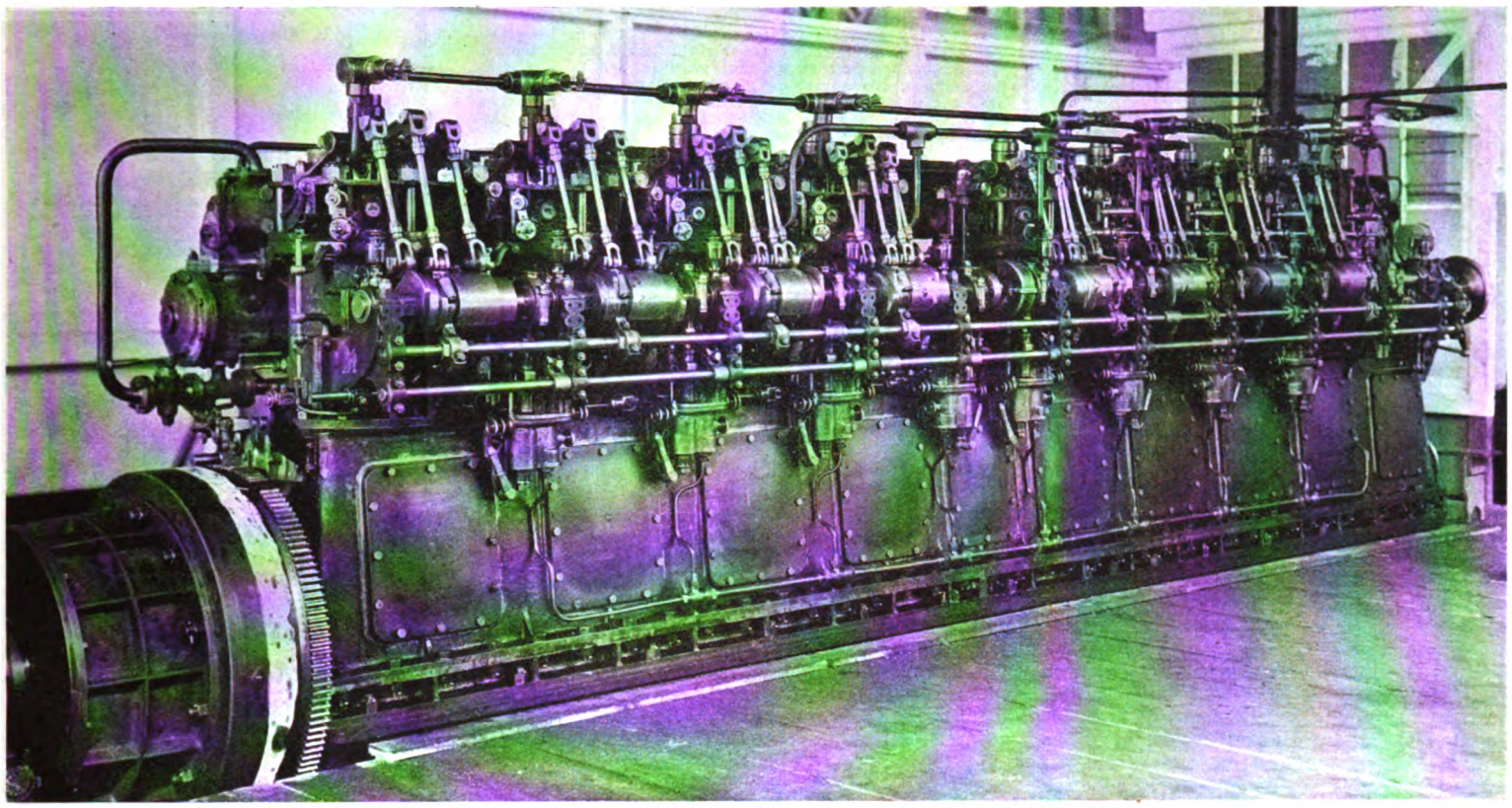


FIG. 3.—SCHNEIDER-DIESEL SUBMARINE ENGINE.

An illustration of a pair of these engines was given in Motorship for December, 1916.

Power developed ..... 1,121 b. h. p.
Number of r. p. m..... 404.6
Fuel-oil consumption per b. h. p. hour.. 240.7 gr. (9.2 ozs.)
Consumption of lubricating-oil per effective h. p. hour..... 8 gr. (0.2 ozs.)

I also am enabled to include the average results of a series of tests made with a four-cycle type Schneider-Diesel engine. This (Fig. 3) was an eight-cylinder 12 in. bore by 11 in. stroke reversible model, and the consumption shows under one-half pound per b. h. p. hour.

Power developed ..... 360 h. p.
Number of r. p. m..... 400
Fuel-oil consumption per b. h. p. hour.. 218.5 gr. (7.5 ozs.)
Consumption of lubricating-oil per effective h. p. hour..... 8.8 gr. (0.3 ozs.)

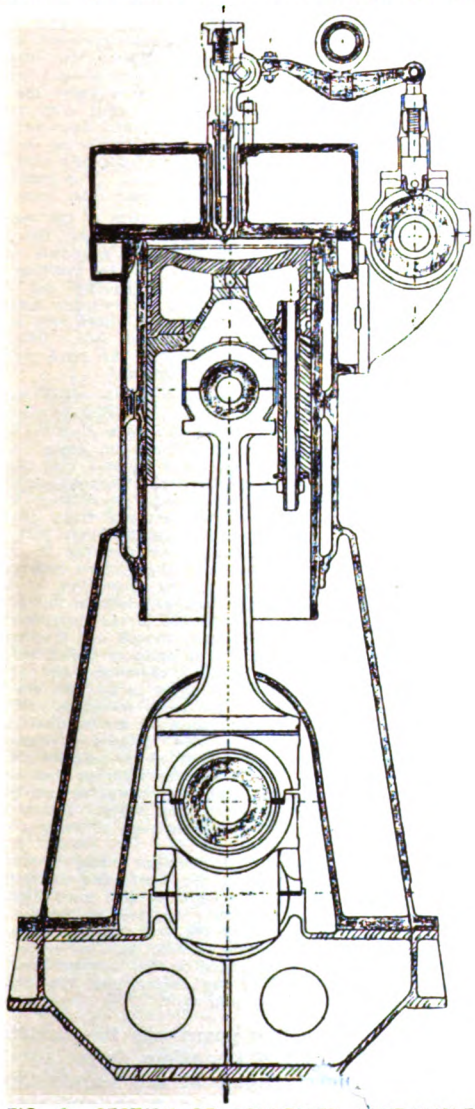


FIG. 2.—SECTION OF SCHNEIDER FOUR-CYCLE SUBMARINE DIESEL ENGINE.

The NORMAND. The engineering and shipbuilding firm of Augustin Normand of Havre, France, also are builders of submarine Diesel engines, but their attempts are more modest than those of Schneider & Co., and all their engines are of the four-cycle principle. For fuels, they use tar oils, (of which there is a large quantity produced in France) mineral oils and vegetable oils.

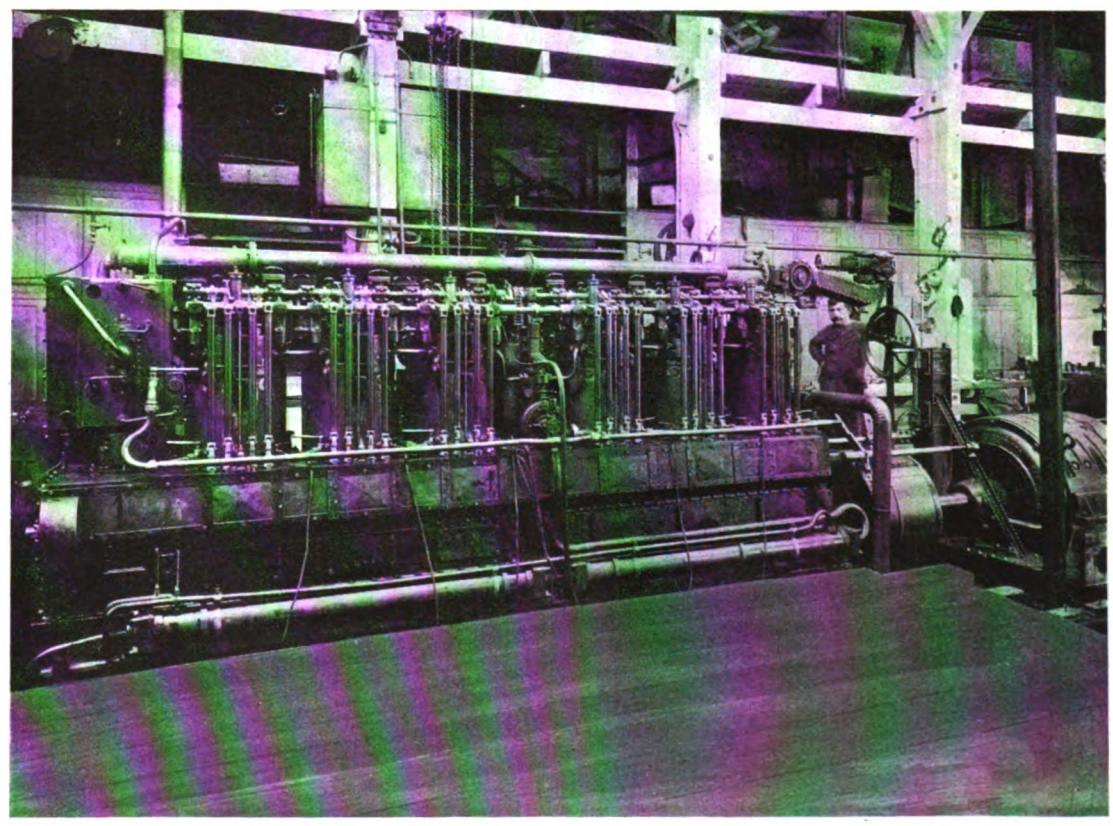
In case of tar of calorific value of 9,000 b t. u., and of petroleum oils at 11,000 deg. calories b. t. u. they have obtained good results in driving the motor on petroleum, a mixture defined proportionately for each power of 30% to 60%, and on tar only at 60% of the normal power and even at an overcharge. The consumption obtained in these different cases is as follows:

Power	Petroleum	Tar
25%	320 gr.	0
50%	25 gr.	245 gr.
100%	0 gr.	217 gr.

The Normand submarine engine is in six cylinders, 13 in. bore by 14.2 in. stroke and develops 420 b. h. p. at 400 r. p. m. It is of the inclosed crank-pit type with a cast-steel chamber and bedplate, with cylinders, and their detachable heads bolted in position. Lubrication is by force-feed, and the drilled crankshaft transmits the oil that already has lubricated the connecting-rod big-ends, to the axis of the pistons, whence it escapes with the pressure remaining in order to lubricate the bottom of the piston, and a device consisting of a little round steel pulley keyed by a pin to a body of cast-iron which supports the segments.

The camshaft has a double series of cams and can be longitudinally displaced, after the push-rods previously have been lifted from the cams, by a movement of an eccentric. Less than 15 seconds is required to reverse from ahead to astern. The consumption of petroleum oil at 11,000 calories b. t. u. is about 185 grs. or 6.259 ozs. (0.39 lbs.) at full load—which is indeed exceptionally low for a submarine motor. The length of this engine without thrust-bearing, but with flywheel, is 18′ 4¾″ by 6′ 2¾″ high above crankshaft center, and 3′ 4½″ wide. The weight is rather high for a submarine motor, as it is 45 kilos (99 lbs.) per b. h. p., including all accessories.

The SABATHE. While not adopted with very many French submarines the Sabathé oil engine ranks among the most important of all designs, and probably the reason of its limited adoption is that the first submarine to have this class of power had to wait five years for its engines. It is built in both the two-cycle and four-cycle designs and its noteworthy feature is the combustion at constant-volume and at constant-pressure, there being two periods of injection, so to be correct it is not a true Diesel-type motor, although it is its nearest relative; in fact,



THE NORMAND 420 B. H. P. SUBMARINE DIESEL ENGINE.

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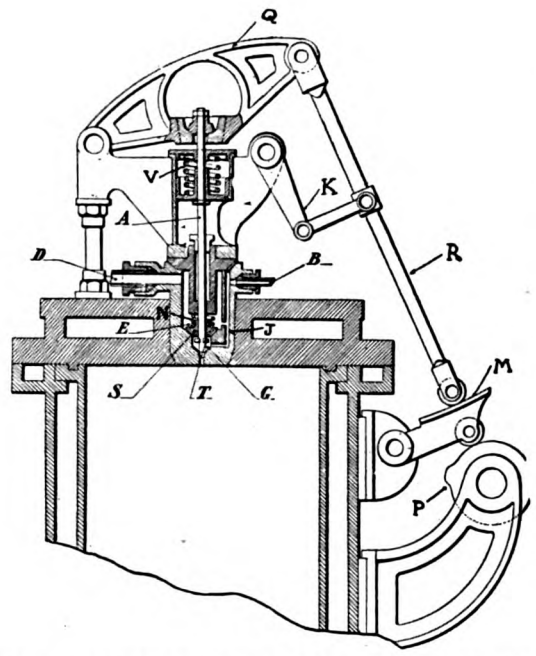


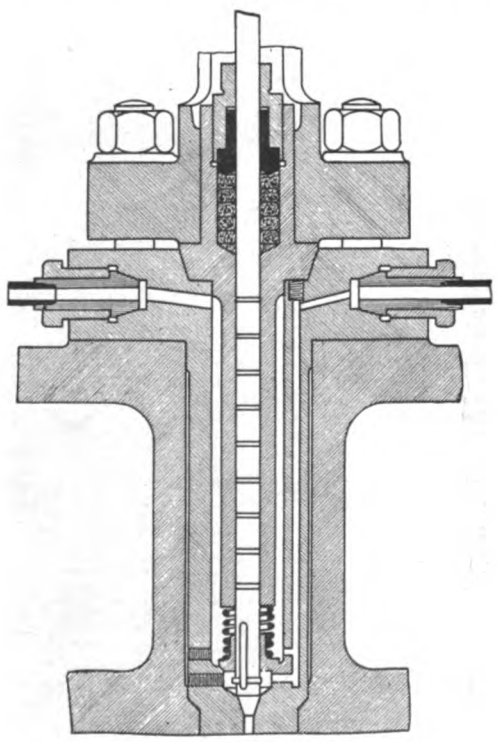
FIG. 4.—ILLUSTRATING THE FUEL INJECTION CONTROL OF THE SABATHE SUBMARINE ENGINE.

may correctly be termed a semi-Diesel motor. In a sense it is a development from the Diesel engine, and in some ways can be considered a better engine because of the greater thermal efficiency. Yet the term super-Diesel is not applicable. Heat for combustion is, of course, obtained by cylinder compared compression, the latter being between 400 and 450 lbs. per sq. inch., compared with 450-500 lbs. for the true Diesel cycle. Just before the piston reaches the top of its stroke a portion of the fuel is injected and combustion occurs at constant volume, increasing the pressure to 580-600 lbs. per sq. inch, and almost immediately the second portion of the charge is injected. It is at this pressure that combustion is concluded. How this is done had best be explained. (Fig. 4).

Oil is forced from plunger-type fuel-pumps, to the two chambers (G) and (E) through the passages (B) and (J). Just as the piston almost reaches the top of the stroke the fuel-valve (A) is lifted by means of the motion transmitted from the cam (P) the motion being affected by the rocker (Q) and the rod (R), causing the fuel in the small chamber (G) to be injected into the combustion chamber by air at 800 lbs. per sq. inch, the latter entering at (D). On the lower end of the valve-stem (A) are several small projections (T) which, as the valve (A) lifts, raises the valve (S) and thus the fuel in the main chamber (E) also is injected, under the same air pressure into the cylinder, which is already in a state of combustion at constant volume. Hence the stroke continues at constant pressure, the pressure having gone up to nearly 600 lbs. The valve (A) is closed by the spring (V) while the valve (S) is shut by the spring (N).

Now, to the small lever (K) the governor is attached, also the engine speed-controller. By moving this lever, the rod (R) is caused to slide on the saddle (M) and its position varies the movement of the rocker (Q) and consequetnly the lift of the valve (A). Thus at slow speeds the valve (A) does not lift sufficiently to raise the valve (S), so that only the small quantity of fuel in the chamber (G) is injected. This partially accounts for the economy of the consumption.

This system of injecting the fuel in two separate charges gives combustion first at constant pressure, and then at constant volume, the advantage of which is proved by the economical consumption results obtained, which I now will give, but this engine has not reached the stage of perfection attained by the Diesel of today.



SABATHE FUEL-IGNITION VALVE.

The FOUR-CYCLE SABATHE. The designers and builders of the Sabathé engine are the Société des Moteurs Sabathé, of Usines de la Chaleassiere, St. Etienne. The four-cycle Sabathé submarine engine develops 500 b. h. p. at 400 r. p. m. in six cylinders on a weight of 33,000 lbs., and is direct reversible. The cylinder bore is 13¾ in. by 13¾ in. stroke. The engine has a fuel-consumption per brake-horse-power of 178 grams, or 6.18 ounces (one gram equalling .035 ounces avoirdupois) of Russian residual-oil at the normal running speed of 400 revolutions per minute. At 350 r. p. m. the engine develops 300 b. h. p. with a fuel consumption of 179 grams per b. h. p. hour. On dropping the engine speed to 250 r. p. m. the power given is 110 b. h. p. and the fuel consumption increases per b. h. p. hour to 200 grams, or 7.055 ounces, but the total hourly consumption at this speed is only 43 lbs. 2½ ozs., due to the great reduction of power. So it will be seen that although the proportionate consumption at low speeds is higher, the engine still remains remarkably economical when running slowly, as it is considerably less than one-half pound per b. h. p. hour, a result many Diesel builders would like to show.

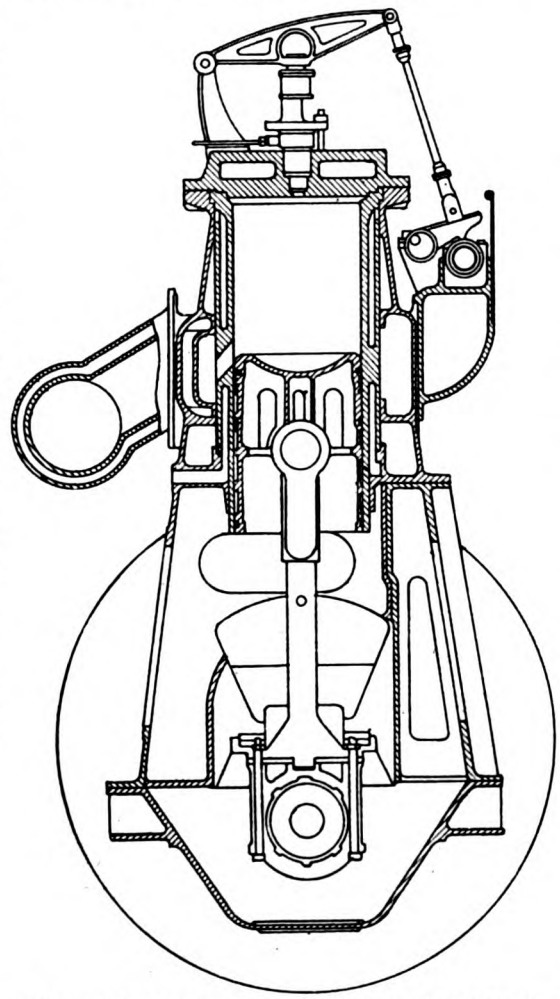


FIG. 6.—SECTION OF THE TWO-CYCLE TYPE SABATHE SUBMARINE ENGINE.

A section of one of the cylinders is shown (Fig. 5) which, it will be noted, are fitted with steel liners. To avoid frictional troubles the pistons have several broad white-metal bands in addition to five cast-iron piston rings. In the head of each cylinder there are four valves, namely, atmospheric-air-inlet-valve, exhaust-valve, air-starting-valve, and fuel-injection-valve, all of which are operated by rockers from a camshaft on the starboard side. There are two sets of cams, one for the ahead motion and the other for the astern movement, and both sets form a sleeve on the camshaft, the sleeve being moved lengthwise for reversing by means of a hand wheel; but first the rollers of the valve-rockers are lifted from the cams by means of a lay-shaft operated by compressed air. A three-stage compressor supplies air to storage tanks, for fuel-injection, starting, and reversing. The pistons can be removed through the doors in the crank case, by the method which I presently will describe, it being the same as with the following engine.

The Sabathé 2-cycle-type Diesel submarine engine (Fig. 6) also is most interesting, and of this they construct two models, namely, an 8-cylinder engine, which develops 650-700 b. h. p. at 310 r. p. m. and a 6-cylinder engine, developing 500 b. h. p., also at 310 r. p. m. The complete weight of the larger engine and outfit is 50,600 lbs. or roughly 22½ tons, which gives a maximum-power weight of a little over 72 lbs. per b. h. p. The smaller engine of the two weighs 33,000 lbs., the same as the four-cycle engine of similar power, and its

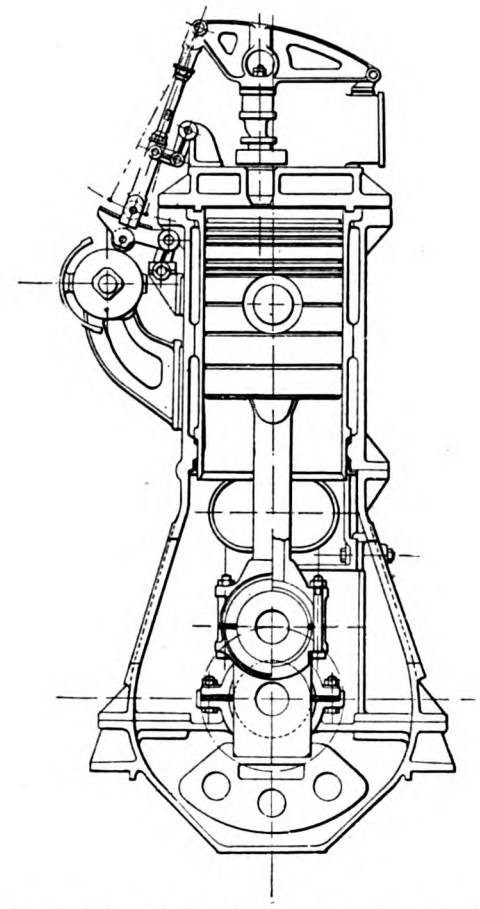


FIG. 5.—SECTION OF SABATHE FOUR-CYCLE TYPE OF SUBMARINE ENGINE.

centre of gravity is 13¾ ins. above the crankshaft axis. It has a cylinder diameter of 12¼ ins. by 15¾ in. stroke, but its speed, it will be noted, is less than that of the four-cycle model.

Realizing that it is necessary to constantly inspect the pistons of Diesel-type engines, and to frequently clean the rings, the Sabathé designers made special provision for removing the pistons. Owing to the limit of height in the submarine, there are quite a number of restrictions imposed, and though by the removal of the cylinder head it is possible to get at the piston, the dismounting of the valve-gear becomes exceptionally arduous within the cramped overhead space of the submarine engine room. Furthermore, the depth of crank-pit needed for drawing the rods and pistons out from below is prohibited by the limits of space under the crankshaft. Consequently the Sabathé crank-case was made in three sections in the 6-cylinder engine, and four parts with the 8-cylinder motor, one side of each crank-case being entirely removable, together with the doors opposite each crank-throw on the other side of the crank-case. This arrangement enables the rods and pistons to be removed from below.

After the removal of the detachable parts of the crank-case section, and of the corresponding doors opposite, the big-end is taken adrift, and the connecting-rod is let down until its palm rests upon the base of the pit. In that position of the rod, the wrist-pin is low enough to be knocked out. Whereupon the piston can be hoisted into the cylinder again, permitting the rod to be tipped over and lifted out sideways through the frame of the engine on one side. The piston then is lowered until it is resting upon the crank-webs, and is slung out by means of a clamping band.

Because long service causes considerable wear with the trunk-type piston, due to there being no crossheads and guides to absorb the thrust, the Sabathé designers also fit the four bands of white-metal, previously referred to, around the pistons of their 2-cycle engine, but it is obvious that this must be made of some special heat-resisting metal, because the pistons are neither water or oil-cooled. In addition to these white-metal bands there are six cast-iron rings above the wrist-pin, while a seventh is added on the lower part. Each pair of cylinders has a scavenging-air chamber in common, and an exhaust-chamber in common, the division between them being formed by cast webs, and the disposition of the air flowing from the scavenging chamber through the ports on one side of each cylinder is favorable to the expulsion of the exhaust through the opposite ports, though one discharge-pipe serves each pair of cylinders. The cylinder bodies are united with the scavenging and exhaust chambers, and are cast integral with each section of the upper part of the crank-case.

The air coming in through the ports scavenges half of the cylinder, because the upward stream of air is directed from the ports. The other half of the cylinder is cleansed of burned gases by means of a stream of low-pressure air entering a scavenging-valve in the cylinder-head, so that not only is the combination efficient, but the scavenging can be regulated by adjustments of the overhead valve. Hence, it will be realized that we have a combination of valve and port scavenging.

It is well-known among engineers that a ring of scavenging valves in the cylinder-head is the most efficient method of scavenging, while the port system is the most simple, so that the Sabathé designers have effected a happy medium. For the purpose of furnishing the scavenging-air there is a double-acting scavenging pump, which, together with a two-stage air-compressor, is arranged in the supplemental crank-case at the forward end of the engine, the two-stage compressor being of the step-piston type.

The LOIRE. Four or five years ago the Société des Ateliers and Chantiers de la Loire built a [illegible] engine of the 4-cycle type developing 420 b. h. p. at 400 r. p. m., and also commenced construction for the navy a 2-stroke en-

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gine of 4,800 h. p.; but I have no means of ascertaining whether they continued this work.

HOLLAND.

The WERKSPOOR. Up to the present time the only concern in Holland that has produced a submarine-type of Diesel engine is the Werkspoor Co., of Amsterdam, and their design radically differs from any other make, containing as it does some bold departures from existing practice. In building this engine they have been assisted by the experience which they had in turning out three Diesel motors for gunboat work, one of which was of 1,500 i. h. p., also the relationship to their mercantile marine engine can plainly be traced.

At the outset they fully recognized that next to reliability and strength, the most important feature was accessibility, the cramped space in a submarine affording no proper room for removing pistons through the cylinder heads, or taking out a crank-shaft endwise, consequently the engine is most unusually accessible, and an entire cylinder can be removed and replaced with a new one in a couple of hours, or a piston removed within fifteen minutes.

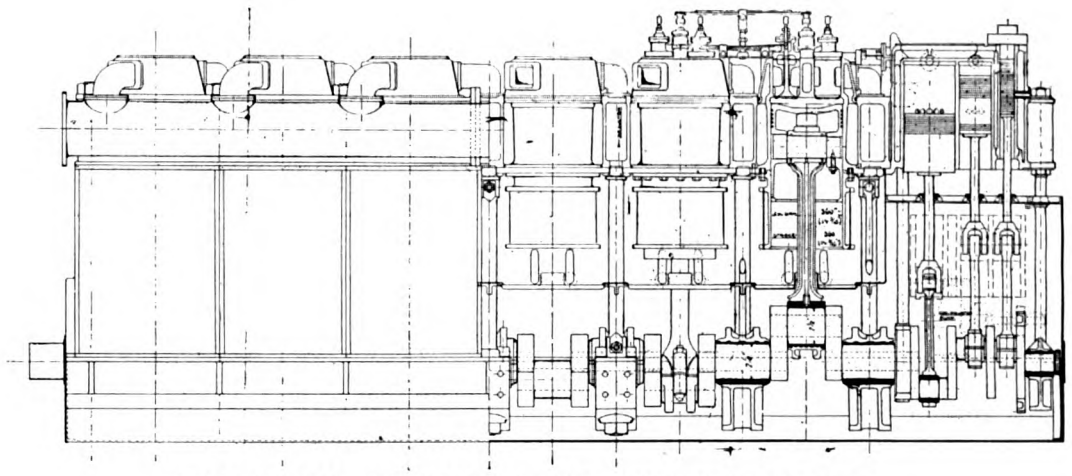

FIG. 7.—GENERAL ARRANGEMENT OF WERKSPOOR SUBMARINE ENGINE.

There are several sizes designed including a six-cylinder 14 3/16" dia. by 14 3/16" stroke, four-cycle type engine of 450 b. h. p. at 400 r. p. m., on a weight of 11 tons and 15½ ft. length; also a 240 b. h. p. engine weighing 10,000 lbs., and a 150 h p. model of 7,000 lbs. weight. But, the only size actually completed is a six-cylinder plant (Fig. 7) of 500-550 b. h. p. at 400-450 r. p. m., on a weight, without flywheel, of 12 tons, or less than 49 lbs. per b. h. p., which is lighter than any of the two-cycle type Diesel engines of about the same power.

Running the length of this engine is a cast-iron water box, or tank, 16 ft. long with holes top and bottom into which the cylinders and intefiral cylinder-heads are placed from below and held in position by a flange. By removing the holding nuts

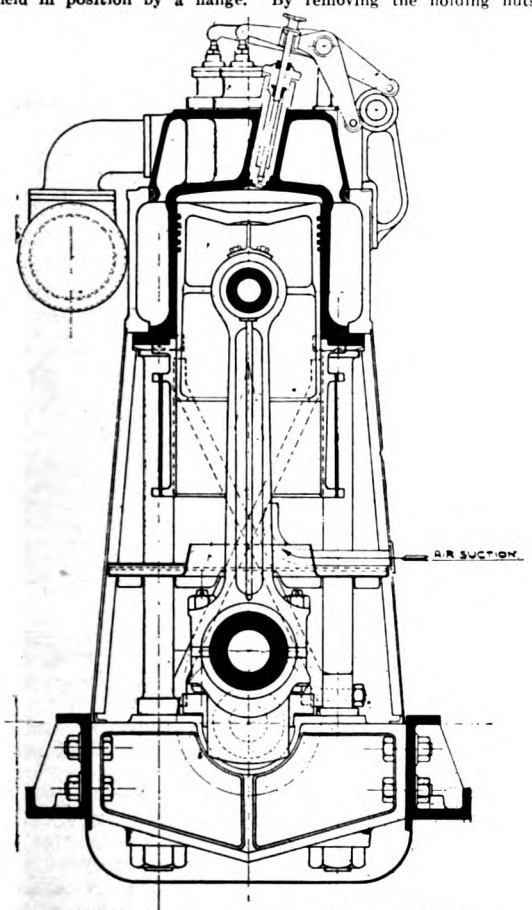

FIG. 8.—SECTION OF WERKSPOOR SUBMARINE DIESEL ENGINE.

a cylinder can be removed and replaced by another in a few hours. At this point of the engine the strain is an upward one, so that the flange pressing against the cylinder tank absorbs the combustion stresses and transmits them through the steel columns down to the main bearings. There is, it will be realized, practically no stress, other than the weight of the cylinder, to be borne by the studs holding the cylinder in place. On the lower part of the cylinder is a water-cooled extension, which can be detached in a few minutes for the purpose of inspecting the pistons or cleaning the rings.

The cylinder tank is supported by wrought steel rods (See Fog. 8) a little ocer 3 in. diameter, which pass through cast-steel bearing-blocks, these being connected in turn to cast-steel girder beams that run the entire length of the engine, the bottom being formed by a ⅛" steel plate to collect the oil. The crank-pit is inclosed by light steel plates. Diagonal rods take up the side stresses. This method of forming a bed-plate is distinctively novel.

The cylinder design provides an unusual amount of water-cooling, particularly around the sides and on top of the combustion space, just where the heat is greatest. Another innovation is the introduction of blade springs for the valve operation, which give less vibration, and occupy less height (very important in a submarine) than coil springs, and only three springs are required for all the valves of two cylinders, instead of one spring per valve.

The manganese-steel crankshaft is of large diameter, being 7½" and 7¾" for the crank-pins, and is drilled for forced lubrication. By unscrewing the nuts at the top and bottom of the steel rods that support the cylinder, they can be lifted up and the crankshaft easily lifted out sideways. The pistons are cooled by a current of air aspired by the upstroke of the pistons, and the warm air thus produced is drawn into the cylinders for combustion purposes, a simple arrangement for which no valves are required other than the usual inlet-valve in the cylinder-head.

The compressor is in three separate stages side-by-side, and are equipped with crossheads and guides, and the high-stage cylinder is fitted with a liner. There is only one valve for the three stages, this being the outlet on top of the high-pressure cylinder. Two fuel-pumps only are fitted, one of which is a standby and with the reservoir-feed arrangement adopted the engine will run for about 15 minutes if one pump goes wrong, giving ample time to connect the standby pump,—a successful system adopted with their mercantile engines. Rights (not exclusive) to build this engine in America have been secured by the Newport News Shipbuilding & Dry Dock Company and by the New York Shipbuilding Corporation. The Royal Netherlands Navy also has two 900 b. h. p. M. A. N. engines in some of their submarines.

JAPAN.

Whether or not Japan has submarine engines of her own design and construction is not known outside of her Navy Department; but, if she has, the motor probably would be a combination of all the leading designs as Japanese show remarkable ability in that direction. Her submarines are installed with Schneider, Sulzer, Vickers, Krupp, Thornycroft, and, I believe, F. I. A. T. engines, all of which are of the Diesel type, with the exception of the Thornycroft sets supplied ten years ago, which were eight-cylinder reversible four-cycle gasoline-kerosene motors 12 in. bore by 8 in. stroke, developing 350 b. h. p., on kerosene and 400 b. h. p. on gasoline, two engines being installed per boat. There were eight sets altogether and the writer personally assisted in the testing of them. The highest powered foreign Diesel engines in the Japanese submarines are the six-cylinder Schneider sets of 1,100 b. h. p. per engine, a pair of which were illustrated in Motorship for December, 1916, so that Japan has at least one high-speed submersible.

ITALY.

The F. I. A. T. The Franco Tosi Co., of Legnano, are building a pair of 1300 b. h. p. submarine Diesel engines, but the principal submarine constructors in Italy are the Fiat san Giorgio of Spezia, who acted in conjunction with the F. I. A. T. Co., the Diesel engine builders, of Turin, with whom they now are affiliated. Just as war broke out they had completed a pair of submarine engines of 1,300 b. h. p. each or 2,600 b. h. p. for a Laurenti-type 700-ton submarine. These must have given the boat a speed of 20-22 knots. Originally these engines were ordered by the German Admiralty but naturally were taken over by the Italian navy. Altogether, in 1915 the F. I. A. T. Co. had on order 18 engines of this power, twelve of which were for similar sized boats, and some were destined for other of the allied navies. The great power of these engines, which is 217 b. h. p. per cylinder, is sufficient to make clear the great progress made with the Diesel engine in Italy, and Fig. 9 illustrates one of these 1300 b. h. p. engines.

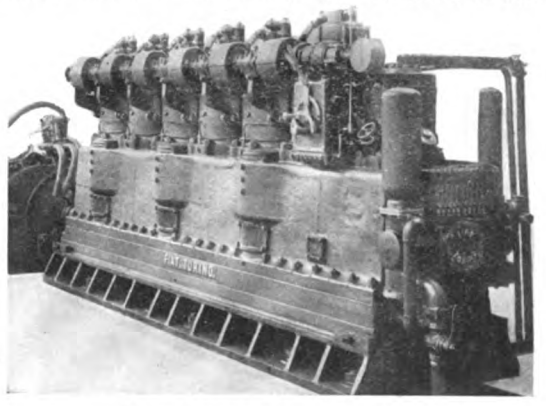

FIG. 9A.—THE SMALLER F. I. A. T. TYPE.

It is in six cylinders and of the two-cycle, single-acting stepped-piston-type, with port scavenging, and turns at 350-400 r. p. m. Its length is about 21 ft. by 9 ft. 3 in. high above crankshaft center, with 4 ft. 3 in. width, and it weighs about 25 tons, or approximately 43 lbs. per b. h. p., which is very low indeed. In order to distribute scavenging air to the cylinders there are three piston-valves driven by means of cranks and connecting rods from a small crankshaft operated by skew-gearing, from the vertical governor-shaft, seen on the extreme left of the illustration. Each of these piston-valves serves for two working cylinders, and the tops of the cylinders in which the pistons operate can be seen just above the three covering plates. In order to examine the valve pistons and

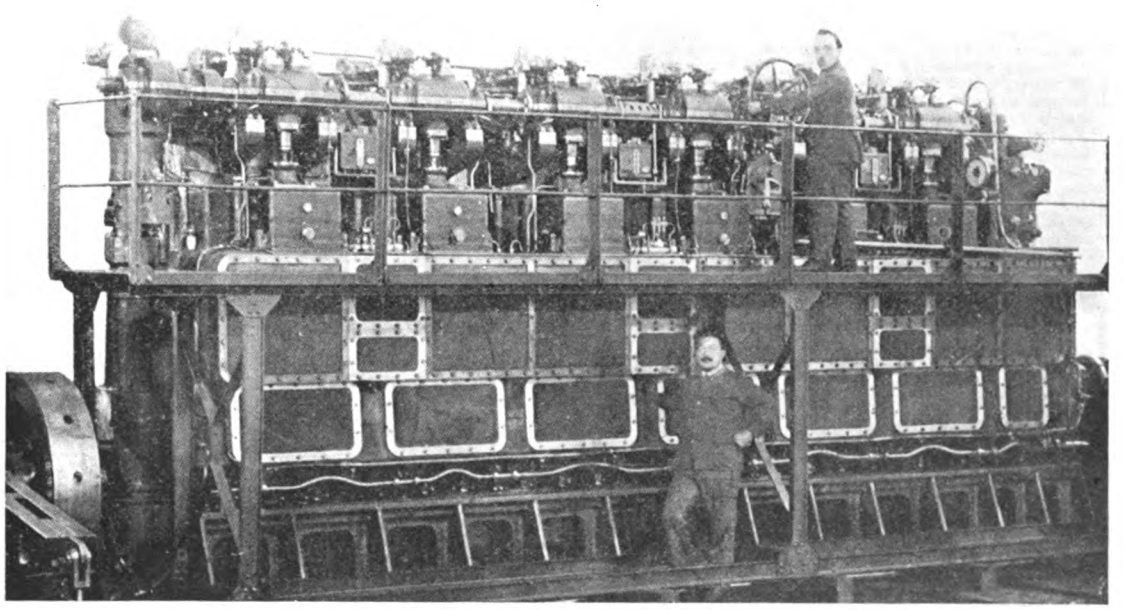

FIG. 9.—THE 1,300 B. H. P. SUBMARINE ENGINE BUILT BY THE F. I. A. T. CO.

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cylinders these covers can be detached. In front of each cylinder there is a plunger-type of valve operated off the camshaft, and this controls the admission of scavenging air to the scavenging ports at the bottom of the cylinders. In some previous F. I. A. T. engines, scavenging was effected by valves in the head of the working cylinder, so that the change is significant. The stepped-piston, or enlarged extension of the working piston, furnishes the scavenging air. One of the trials of the first engine of this power consisted of a run of 114 hours (six days and nights) giving a continuous output of 1,000 b. h. p. The largest Diesel engines ever built by the F. I. A. T. Co. are the twin motors installed in the Brazilian submarine mother-ship "Caera," which are of 2,200 b. h. p. (3,200 i. h. p.) each at 130 r. p. m. The Fiat San Giorgio also have supplied submarines to Norway and Denmark, one of such engines being shown by Fig. 9a.

SWITZERLAND.

SULZER BROS. As may be expected Switzerland has no submarines, but Sulzer Bros., of Winterthur have built Diesel-type submarine engines for several navies including that of the U. S. A., also it is being built, with a few modifications, by the Busch-Sulzer Co., of St. Louis, Mo., for some submersibles now under construction at the yard of the Lake Torpedo Boat Co., of Bridgeport, Conn. One boat already is in service. The engine which we illustrate (Fig. 10) is the section of a six-cylinder two-cycle model 310 mm. (12.2 in.) bore by 300 mm. (11.8 in.) stroke that develops 600 b. h. p. at 400 r. p. m., which is the same size as those building at St. Louis. However, the latter have not the diagonal steel stays as shown in the drawings, and the reversing arrangements are somewhat different.

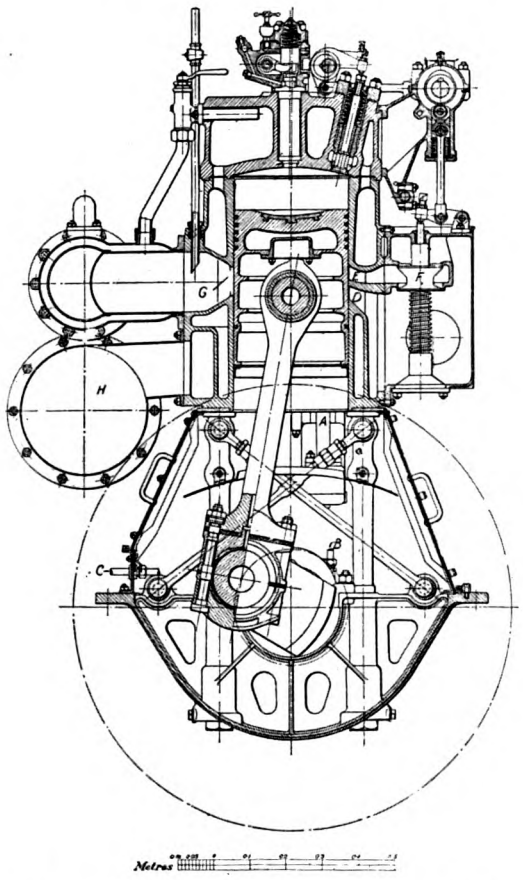

FIG. 10.—SECTION OF THE SULZER SUBMARINE ENGINE.

A noteworthy feature of the Sulzer design is the insertion of a "firing-piece" in the piston top, which is dovetailed in, but in some instances they have had a plate ranged right across the top of the piston. Towards these firing-plates the fuel is injected, and if the heat burns or cracks them they can be replaced. Water cooling is provided for the pistons, the supply being through telescopic pipes, which can be seen at (A) but are not very clearly shown. The discharge pipe can be noticed at (B), and a hand-valve regulates the amount of water used. As in the case of the F. I. A. T. motor just described, scavenging is by ports, although this engine differs inasmuch as the scavenging air is furnished by scavenging pumps driven off the forward part of the engine, and not by stepped-piston extensions of the working pistons.

The method of supporting the cylinders is different from that employed with other makes of submarine Diesel engines, which are usually arranged to carry the weight on the main framework of the engine. In this case steel columns are adopted, and these run down through a cast-iron crank-case. Light steel plates enclose the crank-pit.

SWEDEN.

The POLAR. The only Swedish builder of submarine Diesel engines is that of the A. B. Diesels Motorer, whose engines are known as the Polar, but some of the Swedish submersibles have other makes of European motors installed. Although this company construct two-cycle type Diesel engines for mercantile ships, they hold strongly that the four-cycle principle is the only possible one for a submarine motor. The license to build this engine in America is owned by the McIntosh & Seymour Corporation.

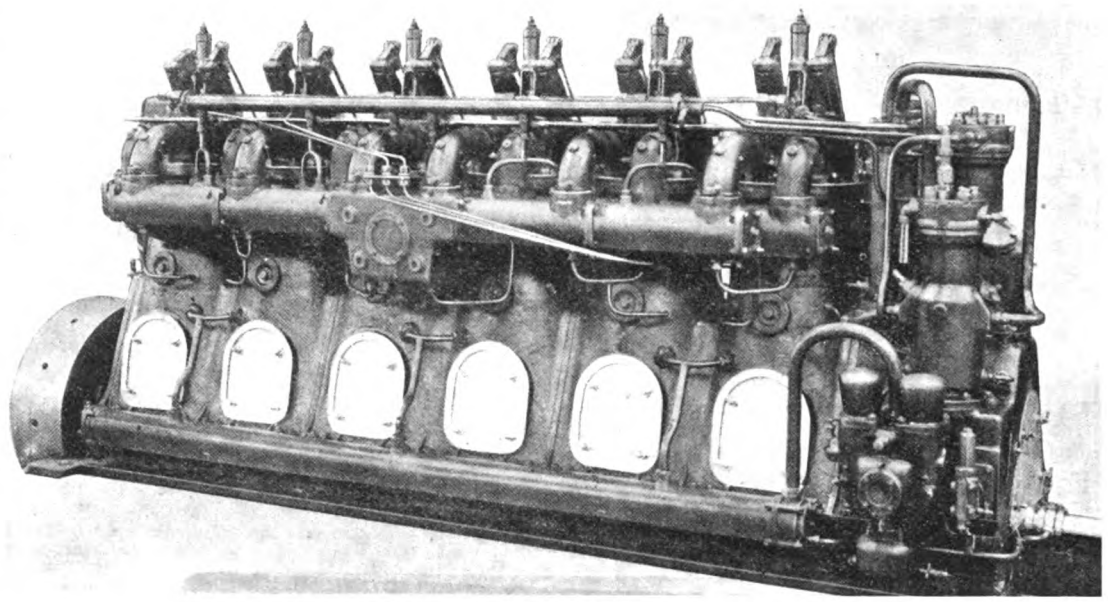

FIG. 11.—THE POLAR 350 B. H. P. SUBMARINE DIESEL ENGINES.

The Polar submarine Diesel engine (Fig. 11) is of the inclosed crank-case type and is built in six cylinders, 11 4/10 in. bore by 11¾ in. stroke, and turns at 300 r. p. m., which means a fairly low piston speed of 800 ft. per minute. It is of the trunk-piston class with a two-stage air-compressor arranged at the forward end integral with the engine crank-case. It is direct-reversible, and the reversing system is most novel, for when running in the astern direction the exhaust valves become the inlet-valves, and vice-versa, so that the timing of only the air-starting and fuel valves remain to be altered. The change-over of the inlet and exhaust valves is effected by a sleeve-valve situated between the inlet and exhaust pipes at the back of the engine. The camshaft is arranged fairly low down and has a push-rod normal-operation of the valves. In order to control the timing of the fuel and air valves there are two cams for each, one of which is a prolongation of the other, and tapered so as to avoid the necessity of raising the valve lever. Its weight is very considerably heavier than most submarine engines of this speed, being about 16¾ tons, or to be exact, 172 lbs. per b. h. p. The bed-plates and cylinders have been made of cast-steel, as also are the cylinder covers, but the liners and pistons are of cast-iron. The crank-shaft is in one nickel-steel forging. Fig. 12 shows a section through the cylinder.

RUSSIA.

The NOBEL. Unless the Kolomaer Co. have built some submarine sets, the only engineers in Russia to turn out Diesel engines for this purpose are the Maschinenfabrik Ludwig Nobel, of Petrograd, although at various times the M. A. N. and Krupps have supplied such motors to the Russian Admiralty. In fact an order was placed in 1913 with Krupps for a number of 1500 b. h. p. submarine engines. That same year the Russian Admiralty prepared plans of a great sea-going submersible, but whether she ever was laid down, or completed, is not known. The Admiralty designs showed a displacement of 5,400 tons, a length of 430 feet, a beam of 38 feet, and a moulded depth of 30 feet. An attempt was to be made to install two Nobel Diesel-type oil engines each of 9,000 indicated-horse-power, as a surface speed of 26 knots was desired. When it is considered that for nearly six years the Russian Admiralty has had 14 Diesel-driven surface-warships in service each of which is over 1,000 brake-horse-power, the inception of this great submersible may have more in it than meets the eye, particularly as the announcement was semi-officially made in August, 1913. This vessel was to have thirty torpedo tubes and five 14 cm. quick-firing guns. If she was built, I doubt if she was

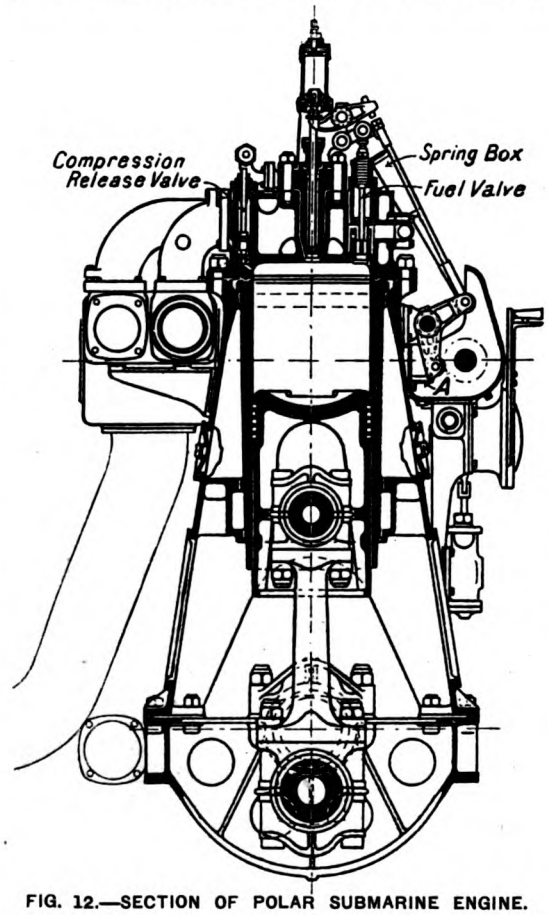

FIG. 12.—SECTION OF POLAR SUBMARINE ENGINE.

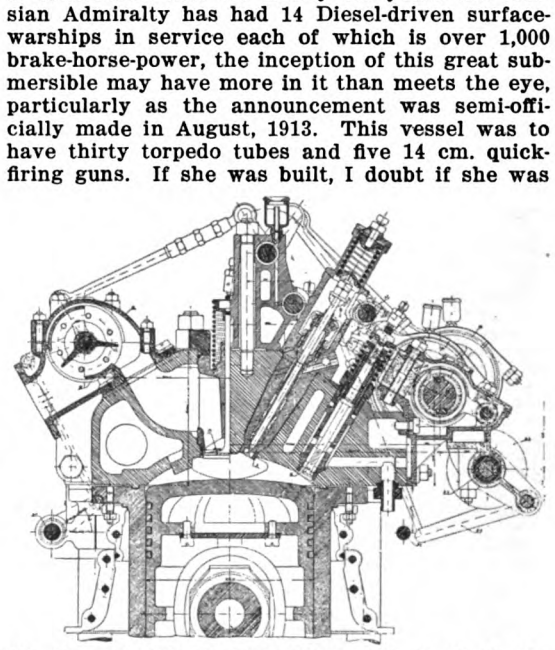

FIG. 13.—SECTION OF THE NOBEL 350 B. H. P. EXPERIMENTAL TWO-CYCLE TYPE DIESEL ENGINE CYLINDER HEAD.

successful. The step is far too great, in fact I believe it did not pass the design stage, and that the keel never was laid.

Mr. Nobel, however, was just the man to do his utmost, because he is a very wealthy man who has taken up Diesel engine construction for a hobby. Several years ago he told me that he had a most important Government job on hand, and that he also had an order from the Russian Admiralty for 22 submarine engines of 1,200 b. h. p. each. If I recollect rightly, a number of "baby" gasoline driven submarines were supplied by an American company many years ago, and the motors of these were afterwards removed and replaced with some small Diesel oil engines made by Nobel.

All of the Nobel submarine engines are of the four-cycle type—with one exception. This was a six-cylinder experimental Diesel motor of the two-cycle type, and of 350 b. h. p. at 400 r. p. m. Mr. Nobel intended to test out two of them in a fast yacht which he built, but he was so disgusted with the results of the first motor on the test-bed that he never completed the second. When one looks at the sectional drawings (Fig. 13) of the cylinder head of this particular engine, one no longer wonders that the motor was not a success. In fact, it seems difficult to believe that Mr. Nobel, with his extensive Diesel experience, allowed such a design to be built. From a scientific aspect the engine was a wonder, and exceedingly clever, but from a practical point of view it was too complicated and did not allow proper cooling of the cylinder head. Its weight was only nine tons, and it was of the steel column, open crank-pit construction. Mr. Nobel also told me that up to 1912, or after 13 years' Diesel work, he had built 500 sets aggregating 60,000 b. h. p., of which 90 engines of 90,000 total b. h. p. were for marine purposes, including naval craft.

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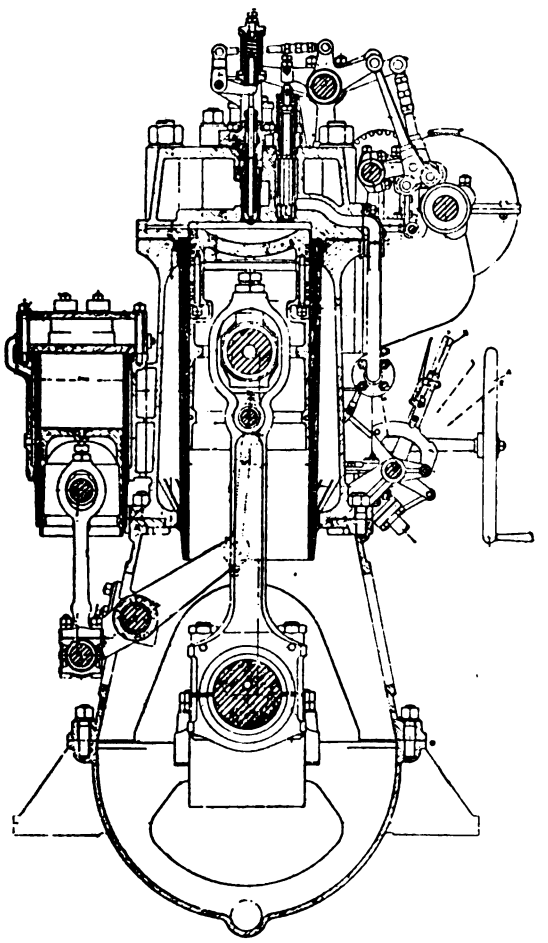

FIG. 15.—SECTION OF THE NOBEL ENGINE.

One of the quaintest submarine Diesel engines built by Nobel was a six-cylinder motor 225 mm. (8.8 in.) bore by 300 mm. (11.8 in.) stroke which developed 160 b. h. p. at 440 r. p. m., and 180 b. h. p. at 500 r. p. m., which was a very small motor for the power, and it only weighed a little over 2 tons, or round about 30 lbs. per b. h. p., which is a world's record. In order to obtain this very low weight the cylinder water jackets were made of sheet copper shrunk in position. Around the crank-pit was erected a light frame fitted with sheet metal doors. But the greatest novelty of all was the overhead camshaft, with its cams operating directly on the valve stems, thus saving the weight of rockers and push-rods, except in the case of the fuel-injection valve, which was fitted in the side of the cylinder head and actuated by a push-rod device.

Reversing of the 500 b. h. p. model of which we give a cross-section (Fig. 15) is carried out in a very neat manner. Each valve push-rod has two rollers spaced apart and staggered, one roller for the ahead action, and one for running astern, there being two cams, side by side on the camshaft for each cylinder. A simple link-gear pushes the rods inwards or outwards as the case may be, causing which ever roller desired to rest on its cam, so that no lateral or longitudinal movement of the camshaft is necessary. This reversing design Nobels first introduced seven or eight years ago on the engines of the gunboats "Kars" and "Ardagan."

THE UNITED STATES.

Unfortunately America has not made strides in the development of the submarine (and of the submarine Diesel engine) equal to those made by other countries, as will be realized by a perusal of the foregoing data, and that as yet we have not arrived at the stage reached by France, Germany, England and Italy, four or five years ago. The absence of competition largely must account for this state of affairs. The size and cruising radius of the submarine rests to the greatest extent upon the power of the engine, and until quite recently American submarine Diesel engine building was limited to one company.

The Navy Department's policy of placing the contract for the hulls and engines together would appear to be principally to blame. Much greater competition with the consequent development and progress would result if bids were asked and orders placed on the engines separately from the hulls. This would not necessarily take away all the engine business from the companies now building, but would force them to make greater and more rapid development because of the introduction of other engine builders into the field. Germany, Russia, France and England all had good engines of their own; but this did not deter each of them from going to other countries even in order to ensure that they had the best obtainable.

The chief submarine Diesel engine builders in this country are the New London Ship & Engine Co., while several years ago the Busch-Sulzer Co., of St. Louis entered the business, and the first pair of their engines (600 b. h. p. per engine) are in a submarine recently running trials at the Brooklyn Navy Yard. Recently the James Craig Engine & Machine Works secured an order for several engines for installation in some old F-type boats that needed new machinery. The Southwark Foundry & Machine Co. were requested to bid with the Southwark-Harris engine for similar installations in some boats, but at the time were unable to do so, conditions at their works not making it feasible. The largest American submarine now under construction is the "Schley," a vessel of 1100 tons surface displacement, and 1500 tons when submerged, which will have four 100 b. h. p. Nlseco-Diesel engines, giving a speed of 20 knots on the surface.

The NLSECO. **Originally the New London Ship & Engine Co., who are the builders of the Nlseco-submarine Diesel-type engine, worked under a license from the Nürnburg engineering works of the M. A. N., and the engines were of the two-cycle type; but lately they have produced a four-cycle type motor of their own design, which we illustrate. (Page 3). Although this company are constructing the 1,000 h. p. sets for the "Schley," the largest they yet have completed for submersible purposes is the 600 b. h. p. model. While they have very kindly furnished details and illustrations, they seem unnecessarily reluctant to reveal the weights, cylinder bore and stroke, and overall dimensions. Were their engines greater in power than the various European engines that are described in this article, one readily could understand the reason for such reticence.**

In the design, special attention has been given to use the weight to good advantage, that is, the bearing surfaces have been designed very conservatively, while stationary parts of the engine, such as bedplate and housing, have been kept comparatively light, consistent with strength and rigidity; but as the weight is not given I am unable to compare it with those of other designs. The working cylinders are mounted on top of a bronze, or cast-iron, housing, which is cast separately from the bedplate, and the air-compressors are direct-driven from the crankshaft at the forward end. The fuel-pump and the control handles are concentrated at one place for convenience in handling. Crank-pit doors for access to the main crankshaft bearings are made as large as possible; but are not sufficiently large to remove the pistons, hence the cylinder heads are detachable. The crank-pit openings are covered with very light easily removable covers.

According to the sectional drawing supplied by the New London Ship & Engine Co., they are using with the 600 b. h. p. model the opposed-valve system that they adopted for their smaller engines. With this design a very peculiar form of cylinder-head casting results, and this is best seen by referring to the sectional view (Fig. 16), it being necessary to have an extension of the combustion chamber, which is not

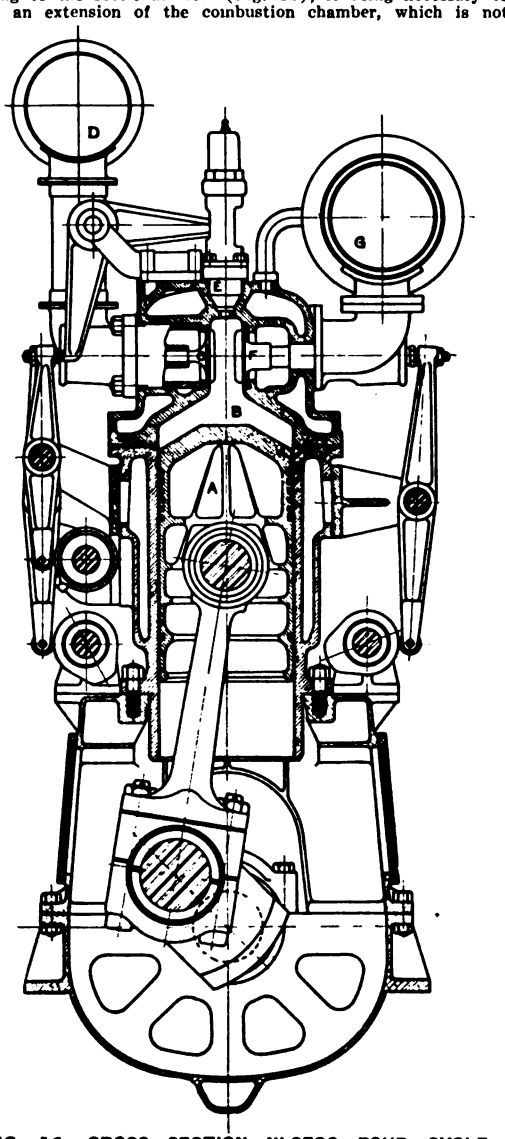

FIG. 16.—CROSS SECTION NLSECO FOUR CYCLE REVERSIBLE ENGINE.

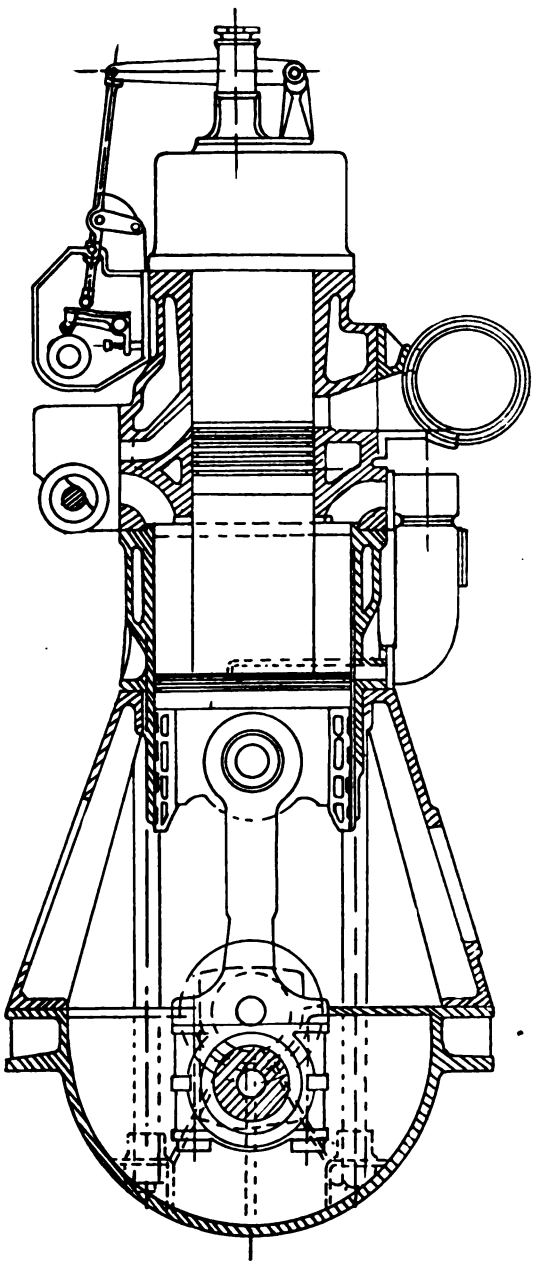

FIG. 18.—CROSS SECTION OF SOUTHWARK-HARRIS SUBMARINE ENGINE.

unlike the hot-bulb of a surface-ignition motor, and in sides of this chamber are arranged the seats of the inlet and exhaust valves, which are horizontal and opposite each other, while the fuel-injection valve is situated vertically in the cylinder head. One advantage of this design is that the fuel-injection valve is quite a little distance from the piston-top and does not receive so much of the intense flame on one spot as otherwise would be the case; but whether this is sufficient advantage to dominate over the peculiar cylinder-head resultant is one for the builders to decide.

Just over the crank-pit housing and on either side, are arranged the camshafts, the cams of which operate directly on the rollers of the valve-rockers; but a double action is necessary to actuate the fuel-injection valve because of its situation; hence two rockers are provided, one above the other, the lower working the upper, (this may be termed a bell-crank), which in turn lifts the valve spindle. Furthermore the lower rocker has a special camshaft situated just above the air-inlet-valve camshaft. All of these camshafts are driven from the crankshaft by means of spur-gearing at the forward end of the engine. The air-starting valves are operated pneumatically from the main control-gear and the relief-valves lift automatically in the case of excessive pressure in the cylinder, and are also arranged to be operated pneumatically from the handling gear for venting the cylinders before starting.

Reversing of the engine is obtained by rotating the camshafts relatively to the crankshafts. All the shafts are shifted simultaneously by means of the pneumatic cylinder acting through levers and sleeves. The handling gear is so arranged and interlocked that the engine cannot start either ahead or astern until the camshafts are in the correct position, hence the cams have been properly set for the desired direction of rotation. The handling gear itself is a very simple affair and the engine is controlled and handled by two hand-wheels, one hand-wheel controlling the direction of rotation and the starting of the engine, and the other controlling the fuel supply and the speed of the engine.

The fuel-pump is driven directly from one of the camshafts and there is a separate plunger for each working-cylinder. The amount of fuel supplied to the cylinders and hence the speed of the engine is controlled by the timing of the suction-valves, which as mentioned above is under the control of the handling gear. An emergency governor is fitted to prevent the engine from racing in case the load is suddenly thrown off.

The air-compressor is of the three-stage type, the two second stages or the second and third stage being above and tandem with the first stage cylinders. The pressure carried on the air-compressor and the amount of air compressed is controlled by a throttle on the first stage suction. The air-compressor cylinders are all cast iron and are bolted to a sole plate secured to the end of the housing and supported from the bedplate.

Forced lubrication is used for all the principal bearings. The lubricating oil is generally supplied under pressure from an independent pump to the main bearings. From the main bearings it flows into the crankshaft to the crankpins and up the connecting-rods to the wrist pins. All surplus oil drains

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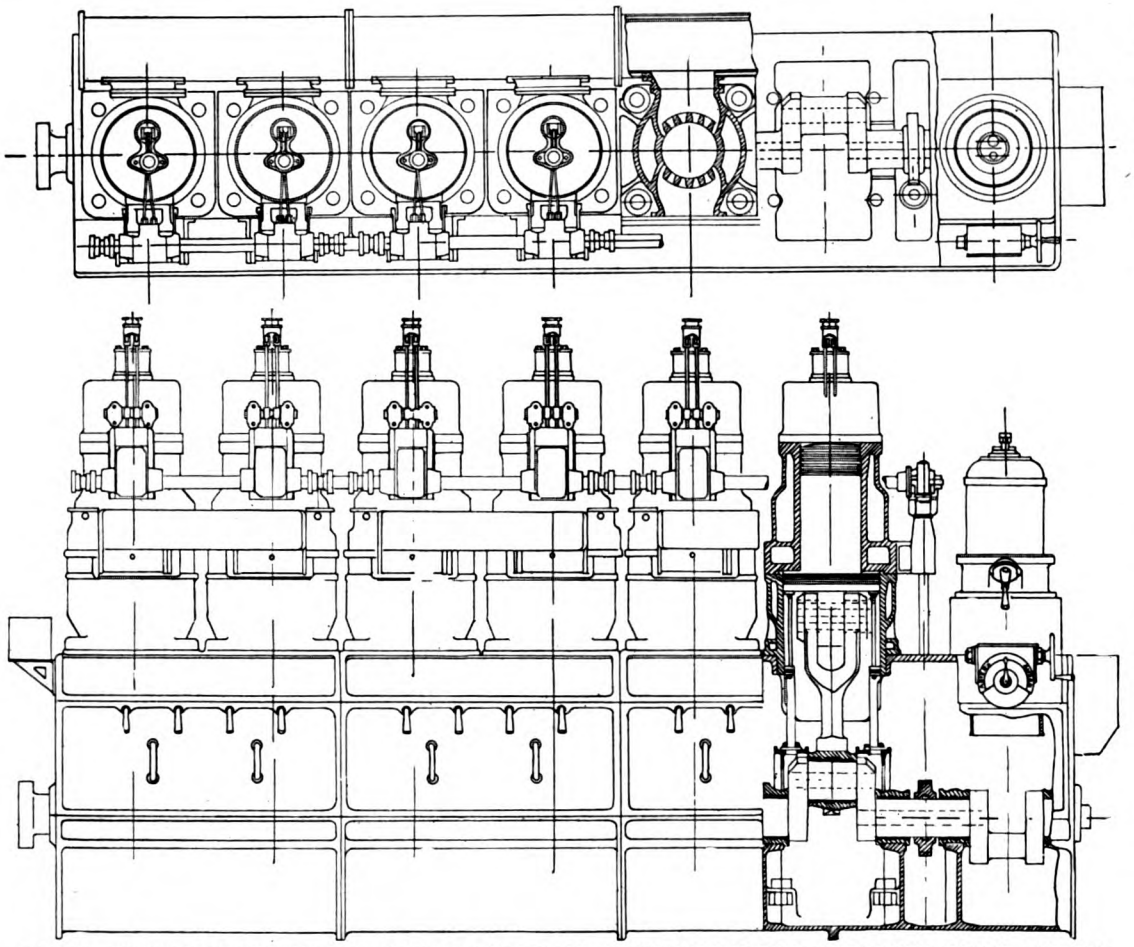


FIG. 19.—ARRANGEMENT PLAN AND CYLINDER HEADS OF SOUTHWARK-HARRIS SUBMARINE DIESEL ENGINE.

back to the crankpit, thence to the sump-tank, and is filtered and used over again. The crankcase is oil tight to prevent leakage and loss of oil. The cylinders are supplied from a positive-feed mechanical-oiler. The camshaft and other bearings except a few which are subject to very little motion and are oiled by hand are fitted with grease cups.

The SOUTHWARK-HARRIS As yet this engine has not been installed in submarines, but the model illustrated (Fig. 18) has been designed specially for the purpose, so we reasonably can expect it to be adopted before long. It is of interest to mention that the British Admiralty have purchased a license for the engine, which was designed by Mr. Leonard Harris, and which is built in this country by the Southwark Foundry & Machine Co.

As with other Southwark-Harris engines, it is of the stepped-piston port scavenging type, and operates on the two-stroke cycle. The lower piston is used for producing scavenging air, and also as a starting engine. It is provided with an extension in the form of an adjustable babbitted slipper, which is used as a crosshead, the guide being formed by an extension of the scavenging cylinder, which is a separate casting from the working cylinder. The cylinder head is detachable, and carries but one valve, namely the fuel-injection valve.

It is somewhat heavier than some of the four-cycle submarine engines, weighing 44,000 lbs. (without an 1,800-lb. flywheel), or 80 lbs. per b. h. p., the power developed being 550 b. h. p. at 375 r. p. m., but the revolution speed is lower than with most submarine engines. There are six-cylinders 12″ bore by 14″ stroke, giving a piston speed of 875 ft. per minute. It is 17′ 11″ long by 4″ wide and 8′ high above crankshaft center.

It is designed to operate with a mean effected pressure of 102 lbs. per sq. inch, and the fuel consumption is 0.55 lbs. per b. h. p. hour. Many of the engines of U. S. naval submarines do not require to be direct-reversible, driving the boat astern being accomplished by the electric motors, but the Southwark-Harris engine is arranged with a direct-reversing mechanism, the weight of which is quite unimportant

The cylinders are carried on a cast-iron frame, which is supported on both sides by steel columns direct to the bedplate and additionally strengthened by supports on the port side, the studs that hold the cylinders passing down into the columns. By unscrewing the nuts the columns on the starboard side can be removed, allowing the crankshaft to be taken out sideways without disturbing other parts of the engine.

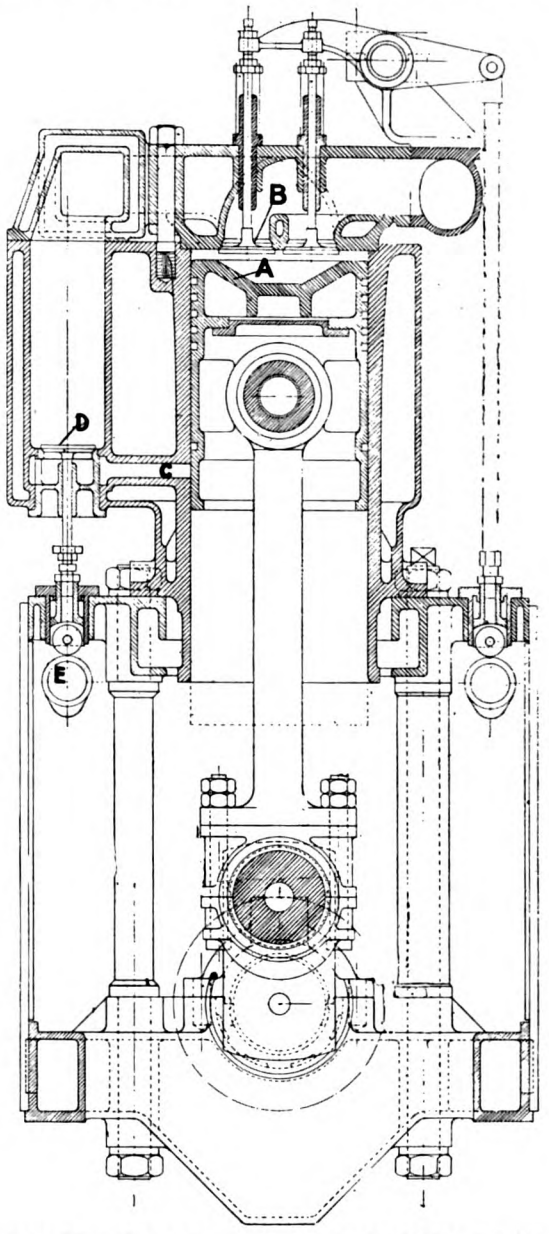
The main bearings are carried right between each set of steel columns, allowing the latter to absorb much of the tension. The crank-pit is covered by two detachable steel doors on the starboard side. At the forward part of the engine are the high and low-stage air-compressor, and intercooler, which charges the storage bottle with air at about 900 lbs. per square inch for fuel injection purposes. On the outer casing of the lower-stage compressor are carried the various pressure gauges, right convenient to the driving mechanic, for at the side is the single-control wheel, by which the engine is started, stopped and reversed.

The BUSCH-SULZER. The engine which the Busch-Sulzer Co., of St. Louis, are building for the Lake type L class submarines is, with minor modifications, similar in design to the Sulzer motor which we illustrate (Fig. 20). They have, however, introduced a short (about 4″) cylinder extension, not unlike that used with Werkspoor engines, for the purpose of assisting removal of the pistons. While this short extension has a tendency to facilitate the removal of the piston from below, it does not do so completely as with the other design mentioned, because the lowering of this piece does not clear the piston top, so that before the rings can be reached, the connecting rod, etc., has to be detached.

The reversing mechanism adopted differs from that used with the Swiss design, and very much resembles the system used with the old Nobel engine. Reversing is effected by means of a double set of cams, but the camshaft is held in fixed bearings, so cannot slide endwise. Instead, two rollers are provided at the end of each push-rod, the rod being guided by means of swing links. The apparent absurdity of having two different cams side by side acting on a pair of corresponding rollers both on the same push-rods is avoided because the rollers do not have the same axes. Although the axes are parallel to each other, they are staggered as one of them is placed in front of the center line of the push-rod and one of them in the rear by the same amount. In other words the planes of the rollers as well as their axes are symmetrically displaced from the center line of the push-rod. Now, the ends of the guide links swing on a center that can be moved nearer to and further away from the camshaft. Fuel, scavenging, and starting valves for each of the six cylinders are reversed; eccentric mountings for fuel and starting rocker levers provide starting, neutral, and running positions in the usual manner.

The CRAIG. In the recent award by the U. S. Navy Department two engines out of six required were ordered from the James Craig Engine & Machine Works. These engines are for installation in the old submarines F-1, F-2, and F-3. Owing to the need for installing the new engines in the existing machinery space and with the existing allowance for machinery weight, there are hard and fast restrictions on the size and the bulk of the new engines. The weight will not exceed 13¾ tons per engine complete with flywheel and with all equipment, or about 102 lbs. per b. h. p.

Each engine is of the four-cycle type and has six cylinders, 12½ dia. by 15 in. stroke, and will develop 300 b. h. p. at 300 r. p. m., and will, of course, be capable of running at considerable overload. The length is 14′ 11″ with flywheel,



SECTIONAL VIEW OF CRAIG SUBMARINE DIESEL ENGINE.

or 12′ 6″ without flywheel, and the height 5′ 8″ above crankshaft center, with an overall width of 3′. As we dealt very completely with this engine in our issue of November, 1916, we need not say much now.

A special feature of the design is the lower exhaust port.

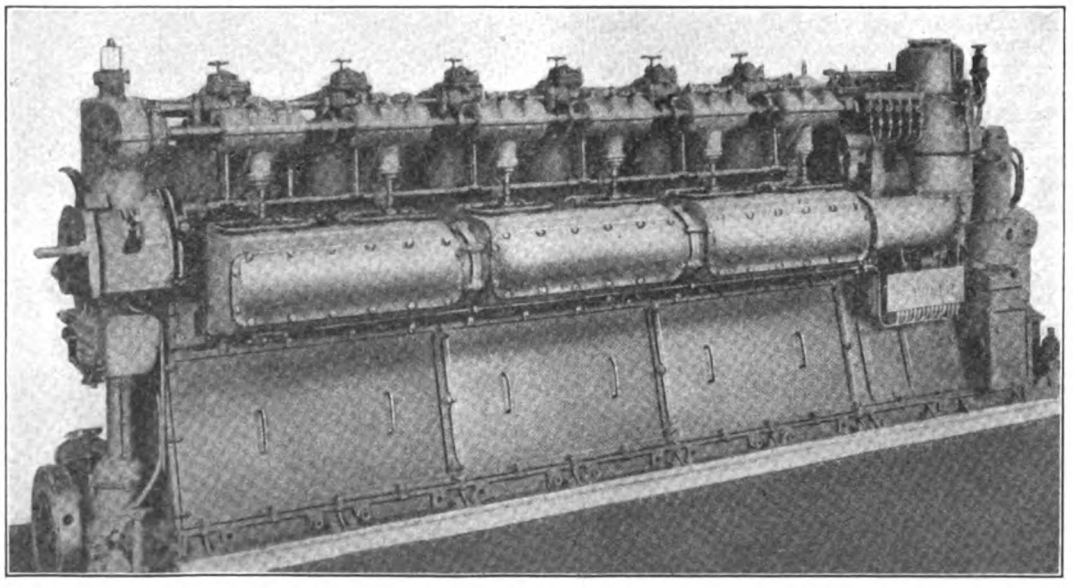


FIG. 20.—AN ENGINE OF 600 B. H. P.—ALMOST EXACTLY SIMILAR TO THAT BEING BUILT BY THE BUSCH-SULZER CO. OF ST. LOUIS.

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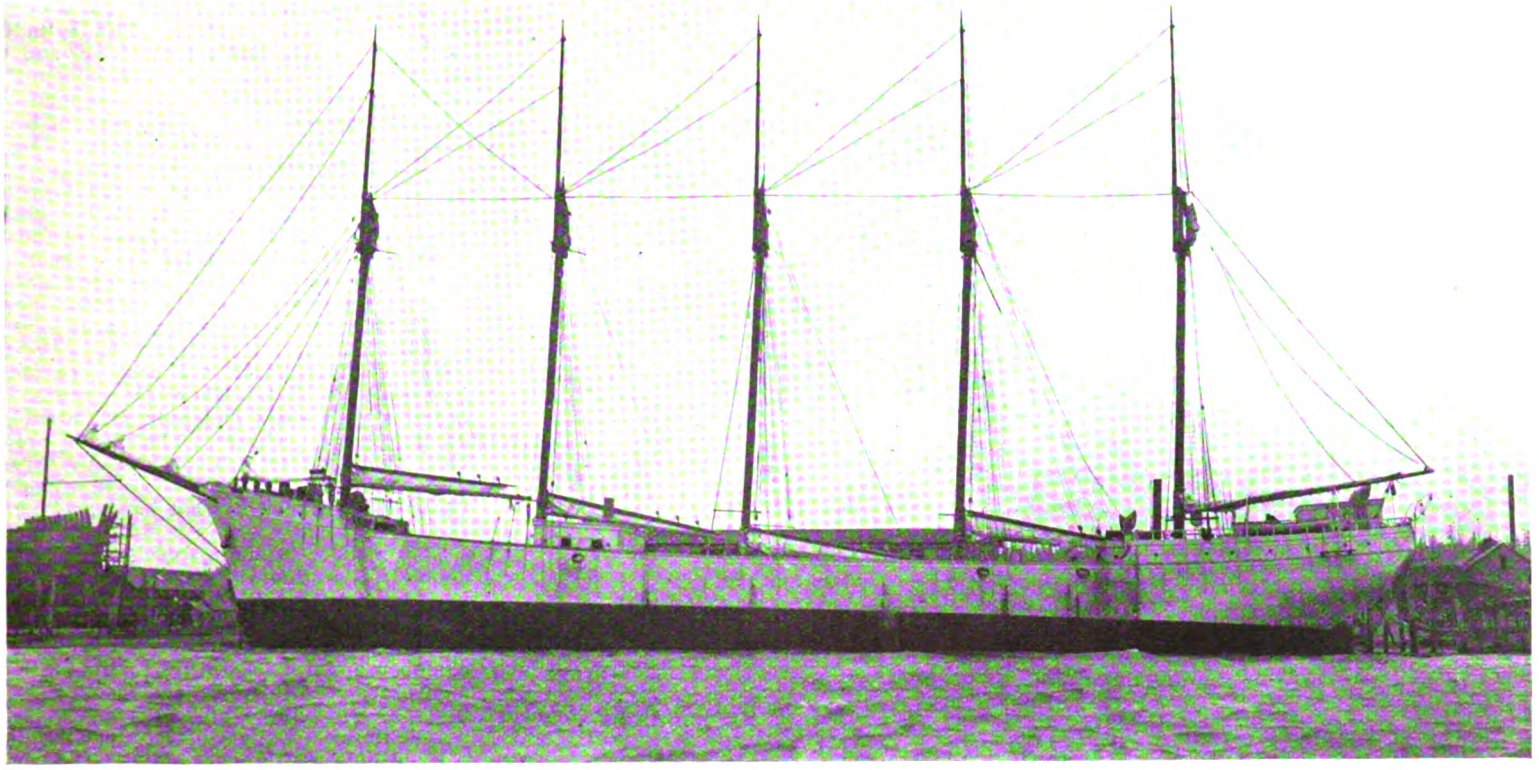
Sumner Oil Engines in Motor Schooner "Santino"

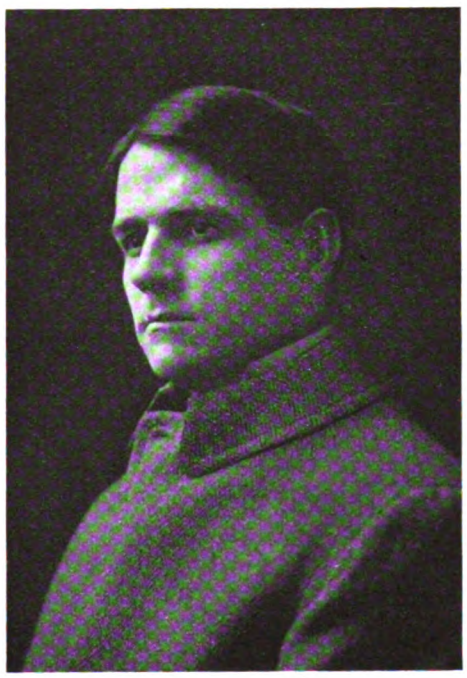
By WILLIAM RUSSELL



AUXILIARY MOTOR SCHOONER "SANTINO."

MOST of the marine oil engines manufactured in the United States at present have come from one of three general sources. They have been imported, that is manufactured under foreign license or have been evolved from a domestic gas or steam engine by some enterprising manufacturer or one or the other who sought to market a more efficient prime mover. The recent launching of the motor auxiliary "Santino" now loading on the Columbia river for New York has served to direct our attention to an oil engine which does not fall within any of these classifications. We refer to the Sumner oil engine manufactured by the H. W. Sumner Co., of Seattle, which is not only an entirely domestic product, but is a new engine in that it was entirely designed within the space of one year by one engineer working alone and is not the product of an organization whose work had been already previously directed along somewhat similar lines. The Sumner engine is furthermore unique in that no experimental sets were built, the first pair of engines being sold direct and in a bona fide and unqualified way from the original plans and specifications, it having received even in this early stage the broad endorsement of the purchasing company's engineers. To the people of the west the Sumner engine has a further point of interest in that it is entirely a Pacific coast product, and in this provincial viewpoint they beg the tolerance of their more blase Eastern cousins since this is the West's maiden marine oil engine.

H. W. Sumner, a technical graduate, who has owned and operated machine shops and foundries at several points in the East before coming to the coast, and who has built the cylinders of some of the largest horizontal gas engines in the United States, came to the Pacific coast some few years ago for his health's sake. In June, 1914, Mr. Sumner began work upon the plans for a marine oil engine, spending over a year in perfecting his ideas in theory, endeavoring to embody the best features of existing engines of this type and the recommendations of the world's best authorities. In March, 1916, after months of careful checking and preparation of detailed drawings, plans were submitted to the consulting engineers of Swayne & Hoyt for whom the "Santino" was built. These gentlemen reported that although no practical demonstration had taken place it was in their opinion safe to place orders for these engines. This was accordingly done and Mr. Sumner in turn let contracts for the actual machine work on the engine to the Puget Sound Iron & Steel Works of Tacoma. Work was begun in August on the first pair of engines and they were completed in four and one-half months.



H. W. SUMNER,
President of the H. W. Sumner Co. and Designer of the Sumner Marine Oil Engine.

Mr. Sumner had one thing principally in view in the design of his engine and that was to produce a power plant with which the average marine steam engineer would be able to familiarize himself in the shortest possible space of time. One of the ideas behind this was that it did not behoove the builder of a marine internal combustion engine to close his ideas to the fact that years and years of steam practice had evolved many things in connection with marine work which were just as applicable to a marine oil engine as to a triple expansion steam engine. The result of this viewpoint of Mr. Sumner's is that his engine as will be seen from the photographs reproduced herewith and on the cover of this issue of Motorship is in appearance very much like a marine steam engine.

In general it can be said that the Sumner is a 2-cycle, surface ignition, vertical open column marine engine, the first model (that illustrated herewith) having 4 cylinders, but the designer's plans comprehending various multi-cylinder combinations up to eight cylinders. The four cylinder model, designed to operate at 210 r. p. m., develops 350 b. h. p. at that speed, this having been determined by actual block tests with an engine operating under full load. It is designed to work on fuel oil ranging in gravity from 23° to 28° Baume, such as would be represented by Diesol and Calol manufactured on the Pacific coast by the Union Oil Co. and the Standard Oil Co. of California, respectively.

Starting and reversing is accomplished by means of compressed air, followed by oil injection and can be done as rapidly as a steam engine can be handled. The air is distributed to the cylinders by a revolving cylindrical valve loosely splined on gear shaft and ported so that the compressed air is given to the proper cylinder to make the engine rotate in the direction desired. This valve is operated by a single lever accessible from the engineer's platform. The distributor valve is supplied with oil from the forced feed lubricator.

The Sumner engine has a normal maximum explosion pressure of 250 lbs. It has safety valves which if it should have a pressure higher than 250 lbs. relieve that pressure. However, as a basis for calculation of strength of parts a maximum explosion pressure of 350 lbs. was assumed and the usual factor of safety taken.

The cylinders are 16½ in. in diameter with a 22 in. stroke, unit castings, interchangeable, jackets cast on and made of close grained cast iron. The intake and exhaust ports are incorporated in the cylinder and are uncovered by the piston at the bottom of its stroke, the exhaust

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Not only does the lower exhaust take care of about 80% of the burned gases, but it exhausts the hottest part of these gases, yet they are not exposed to the intense heat of the combustion, as during combustion it is covered by the piston, nor does the lower exhaust-valve have to be opened against any internal pressure. Again, neither does the main exhaust-valve (B) open against pressure, for the auxiliary exhaust relieves the pressure within the cylinder before the main exhaust-valve is opened. In fact, the auxiliary exhaust is really the main exhaust, while the valve-in-the-head is merely an outlet for the entrapped gases, that are left. The main valve (B), of course, opens when piston (A) starts on the up, or scavenging stroke.

The framework of the engine consists of a heavy bed-plate, which carries 16 forged steel columns, the latter carrying a cast-iron table on to which the cylinders are bolted, each cylinder being cast and fitted separately. All the columns are machined, as well as the cross-stays, to a nice finish, thereby adding to the appearance of the engine. Light steel plates, or doors, easily detachable, are fitted to the columns, and these act as splash plates.

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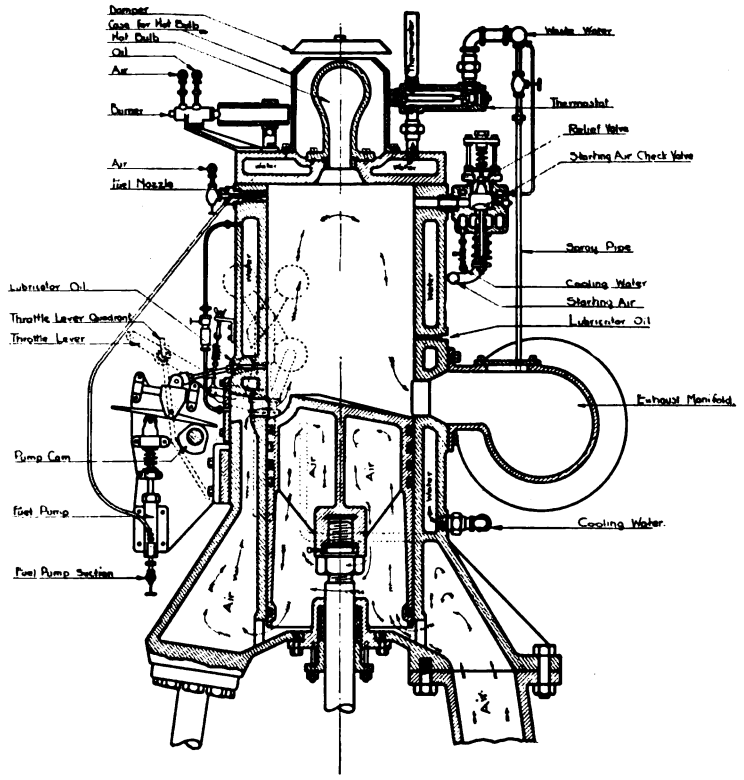

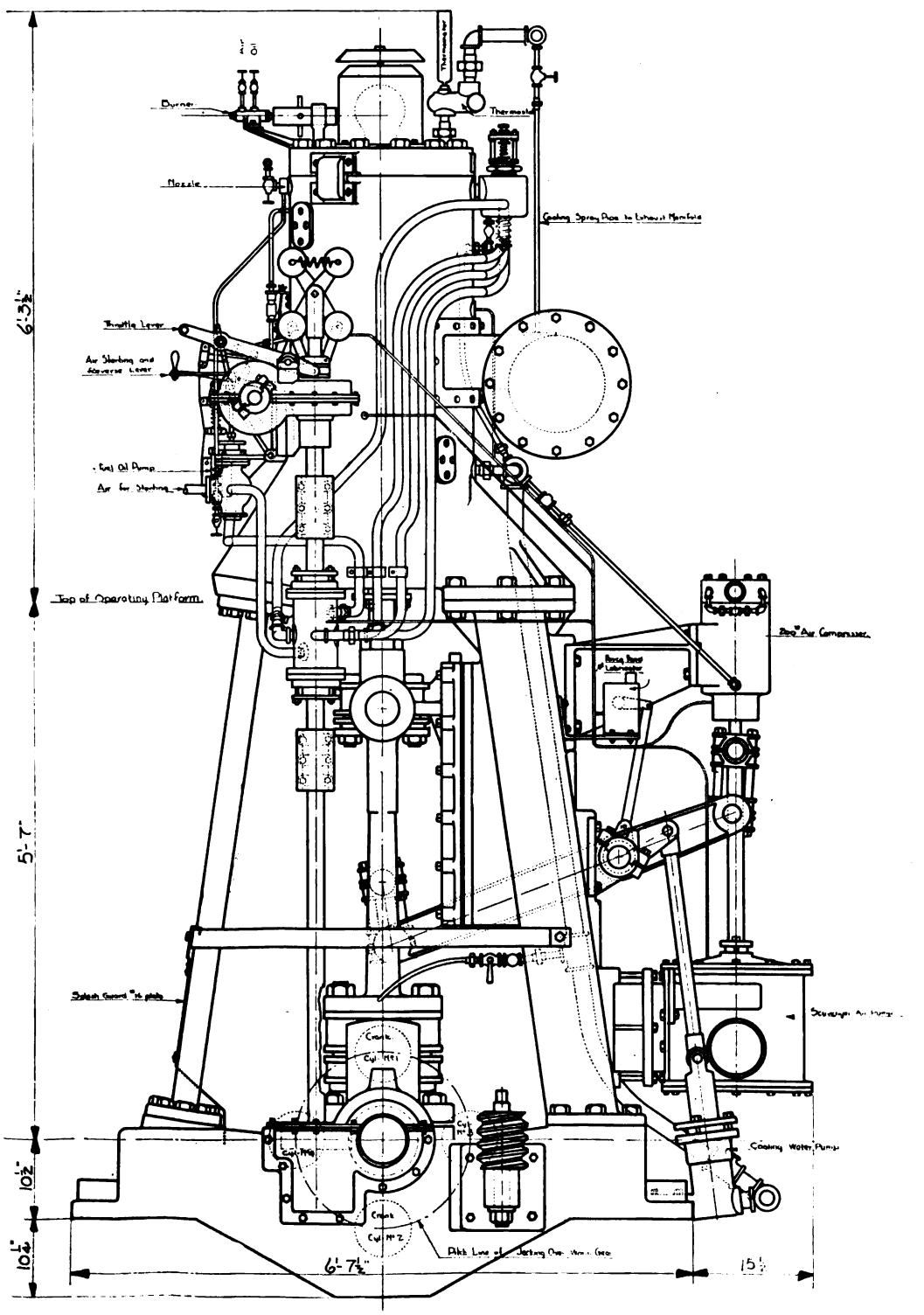

ABOVE: SECTION OF CYLINDER AND PISTON. BELOW: PLAN OF FORWARD END OF SUMNER ENGINE.

ports being located on the one side of the cylinder and the intake ports diametrically opposite.

The exhaust port is uncovered at such a point in the stroke that the pressure of the burnt gases in the cylinder falls to about atmospheric pressure before the intake port is uncovered. At the instant the intake port is opened the scavenging air in its receiver is at approximately 8 lbs. gauge pressure. The bottom ends of these cylinders are provided with flanged bosses for securing the cylinders to the columns. The cylinders are secured in a fore and aft direction, and to each other, by a heavy steel tie member upon the front side of the engine, and by the cast steel manifold upon the exhaust side. The design of the intake and exhaust port is such as to permit easy access to each individual port. The water jacket covers the entire cylinder, except where prevented by the air intake and exhaust ports. Bosses are provided through the water jacket at four points, approximately 90° apart for the cylinder lubrication. The water jacket core does not extend through the top end of the cylinder, permitting of a countersunk composition gasket joint for the cylinder heads.

The stuffing boxes are cast separately, and machined to suit. They are secured to the cylinder with studs and nuts and provided with bronze throat bushings. The glands are of cast iron, machined to suit, secured by three studs and nuts. Soft packing is used. The stuffing boxes are designed so that hard packing can be used.

The cylinder heads are made of cast iron with double walls stiffened with three ribs, which are used to distribute the cooling water. The heads are accurately machined to fit the cylinders and to allow the securing thereof of the combustion chamber and its hood. It is also machined for supporting the torches and cooling water intakes and discharge. The design is such as to permit the use of the shortest studs practicable.

Hand holes, with cover plates, are provided for cleaning out the water jackets and ports.

Such clearance is provided at the top end of the cylinder that the compression pressure will not exceed 125 lbs. gauge. At the lower end of the cylinder the compression space for the scavenging air is such that not in excess of 8 lbs. pressure may be obtained.

The open column construction is the most striking outward feature of the engine and from the point of accessibility there is much to be said in favor of it. The enclosed type of large 2 cycle engine draws its combustion air first into the crank chamber, which is used as an air receiver, necessitating the enclosure of all working parts. The Sumner engine draws the air into a receiver which is the cross head or back column and avoids the necessity of enclosing the working parts. On the front side the cylinders are supported by forged steel columns having flanges at each end and machined to fit the cylinder and bed plate respectively. The back columns, one for each cylinder are provided with flanges for bolting to the bed plate and cylinder respectively. The backs of these columns are machined to provide for bearing boxes in which shafts are mounted to pivot the pump driving beams. The front sides of the columns carry working faces for the cross heads.

The engine bed plate is in one casting of cast iron. It consists of five "U" shaped girders. The upper part of the bed plate and lower flanges are connected to the webs and stiffened by ribs. It is properly finished and faced for crank shaft brasses and bearing caps. Provisions are made for securing the thrust block and turning gear bracket.

Pistons are made of cast iron, accurately machined, and each provided with four piston rings at the combustion end. Four substantial ribs cast to the piston head support the boss for securing to the piston rods. The piston heads are tapped for eye bolts for removal. They are designed to avoid distortion under high temperature.

Piston rods are of forged mild steel finished and polished where they run through the stuffing boxes. Ample fillets at all shoulders. The upper end of the rod is screwed into the piston boss and securely locked with a nut which is in turn secured from revolving. The lower ends are similarly secured to the cross-head.

Cross heads are of cast steel and contain bronze roll out bearings for the gudgeon pin. The bearings are prevented from turning by steel strips which are secured when tightening up the bearing cap. The cap is of cast steel secured by turned bolts, which are prevented from revolving by square heads. The cross heads have a projecting face to which are secured the slippers with bolts in reamed holes.

Cross head pins are of forged mild steel, case

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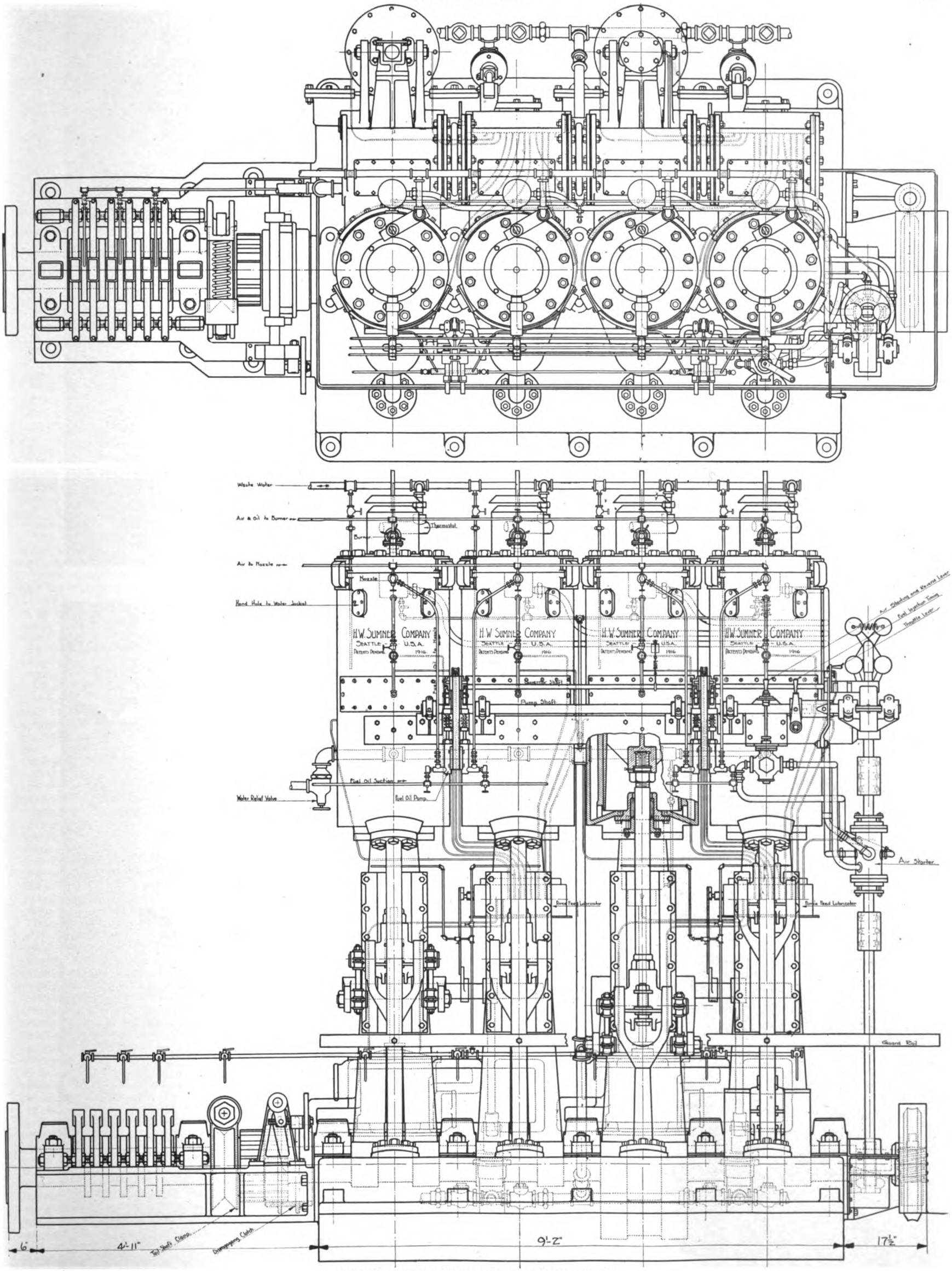

GENERAL ARRANGEMENT PLAN OF SUMNER ENGINE.

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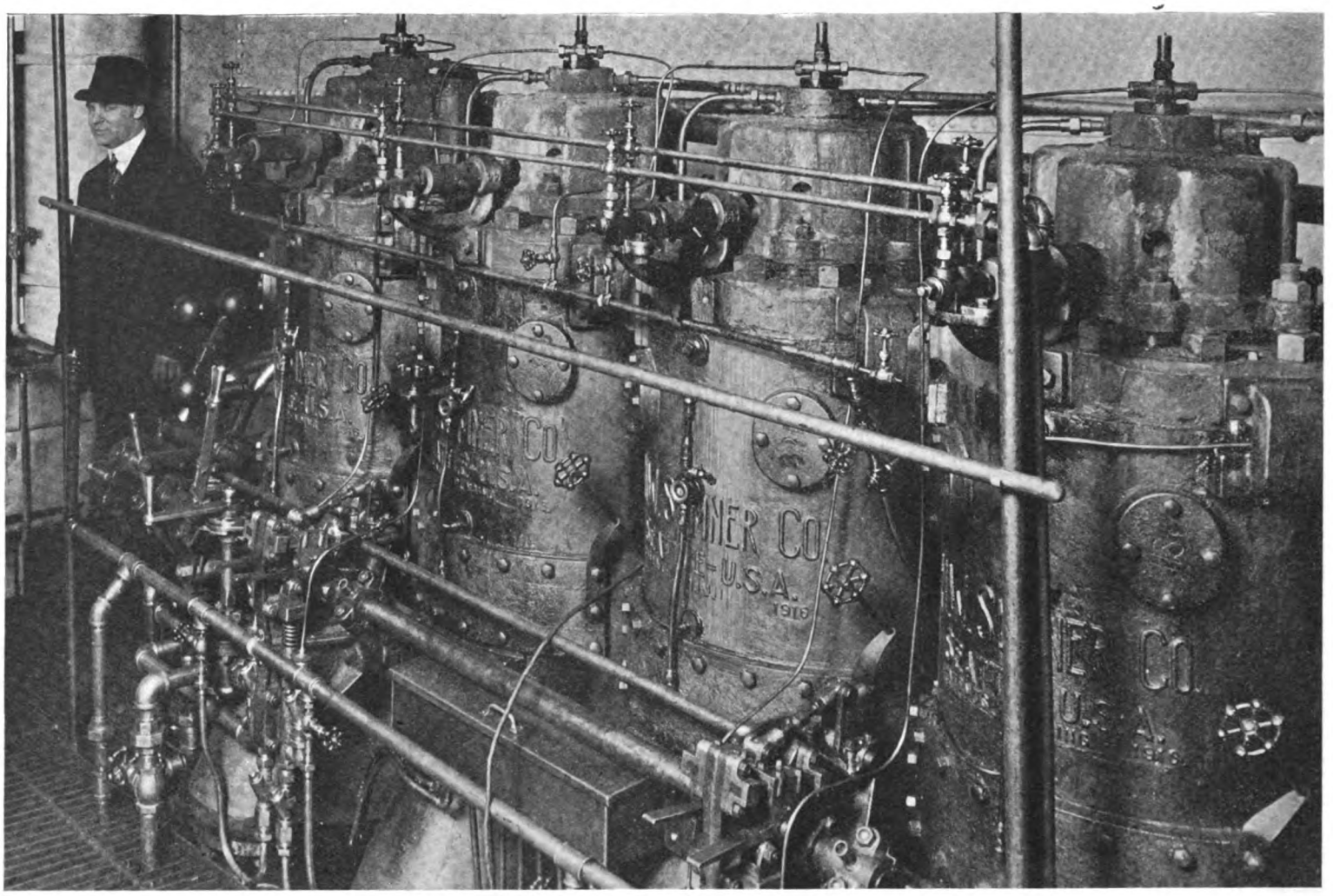
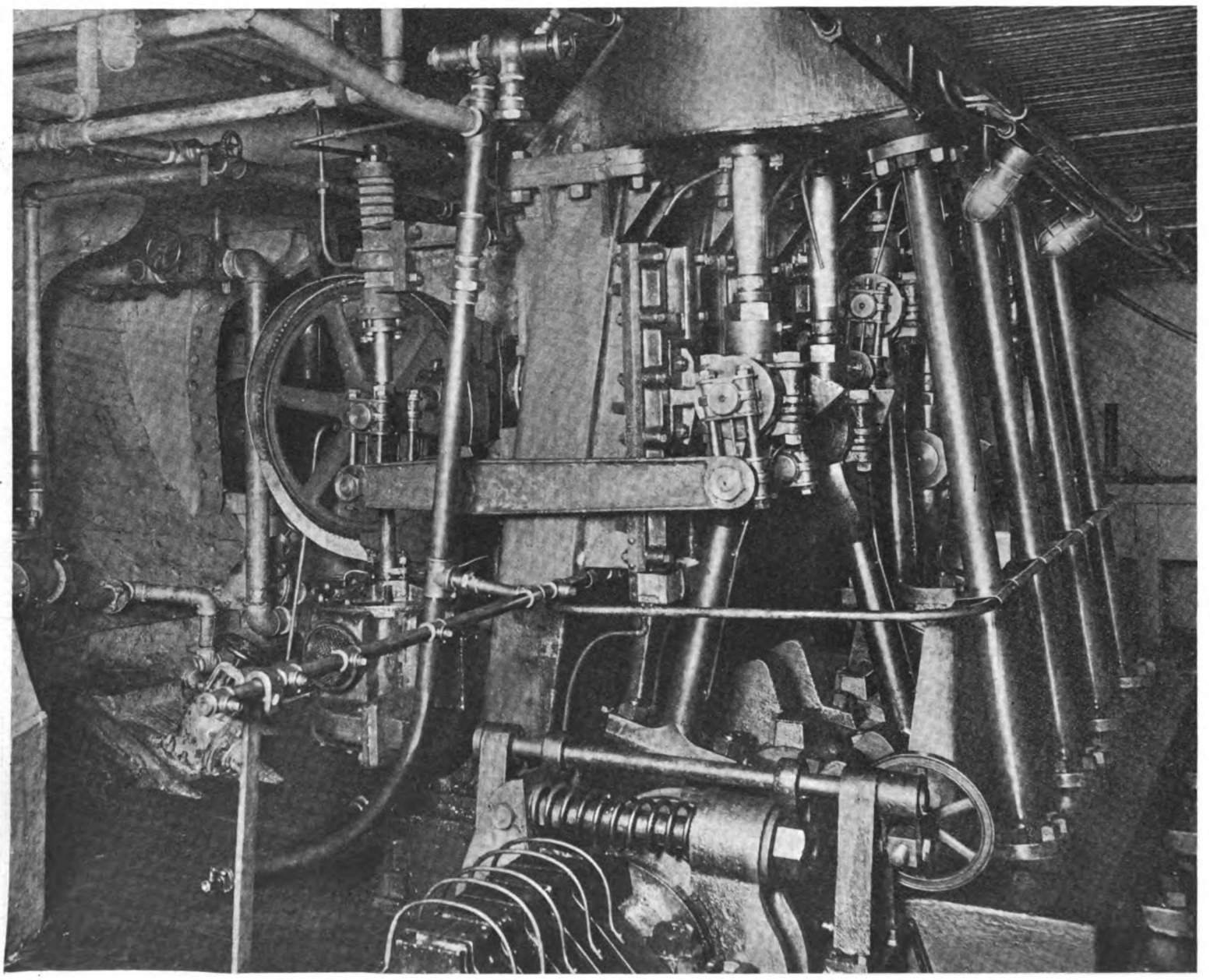


ABOVE GRATING—CYLINDERS AND CONTROLS OF STARBOARD ENGINE.



BELOW GRATING—AFTER END OF PORT ENGINE SHOWING OPEN BASE CONSTRUCTION.

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hardened, ground and polished upon the running surfaces. They are shrunk into the eyes in the yoke at the upper end of the connecting rod. They are shouldered and two of them are provided with extensions to which are connected the links for driving the pump beams. The crosshead pins which do not drive pumps are also secured by steel discs and screws.

Crosshead slippers are fitted with white metal secured in dovetailed grooves, hammered and accurately machined. The "backing up" surface is of the same design but with approximately 50% of the area of the "go ahead" surface. The upper ends of the slippers are provided with a cast brass oil box delivering oil to grooves on the face of the slippers. Provision is made for taking up wear in both directions.

The pressure does not exceed 50 pounds per square inch of slipper in the "Go ahead."

Crosshead slides are of cast iron of ample section, accurately machined and each fitted with turned through bolts and the necessary adjusting shims.

The connecting rods are of mild steel forgings having no welds, machined and finished all over. The crosshead end is yoked for the gudgeon pin. The section at connection of the yokes is that of a truncated cone, which provides the maximum stiffness.

The bearing boxes are of cast steel so designed as to possess a uniform section of metal for casting. They are accurately machined and fitted for centering into the connecting rod. The "brasses" are lined with white metal, hammered and machined, and fitted to the crank pins and properly channeled for oil distribution. The bolts are mild forged steel turned, body-bound. The heads are doweled to prevent turning, each bolt provided with a collared nut and set screws for locking the nut. Liners are fitted and also dowels so as to remove liners without withdrawing the bolts.

The crank shaft is a mild steel forging in one piece accurately machined. Each web carries a counter-balance of cast steel rigidly secured to it with through bolts. All journals are smoothly and accurately turned and the crank pins parallel to the main journals. The front end of the shaft is provided with a jacking worm wheel of cast steel; and a helical gear of case hardened machine steel, heat treated and incased in a grease box, for driving the injection oil pumps. The after end of the shaft is provided with a disengaging coupling.

There are five main bearings all alike, for the crank shaft. The thrust shaft has two bearings, both alike. Each bearing consists of a bottom and a top brass lined with white metal secured in grooves hammered and machined and prevented from rotating by a steel strip. The bottom brasses can be rolled out when the caps are removed and the weight of the shafts relieved. Each cap is cast integral with an oil box having hinged covers.

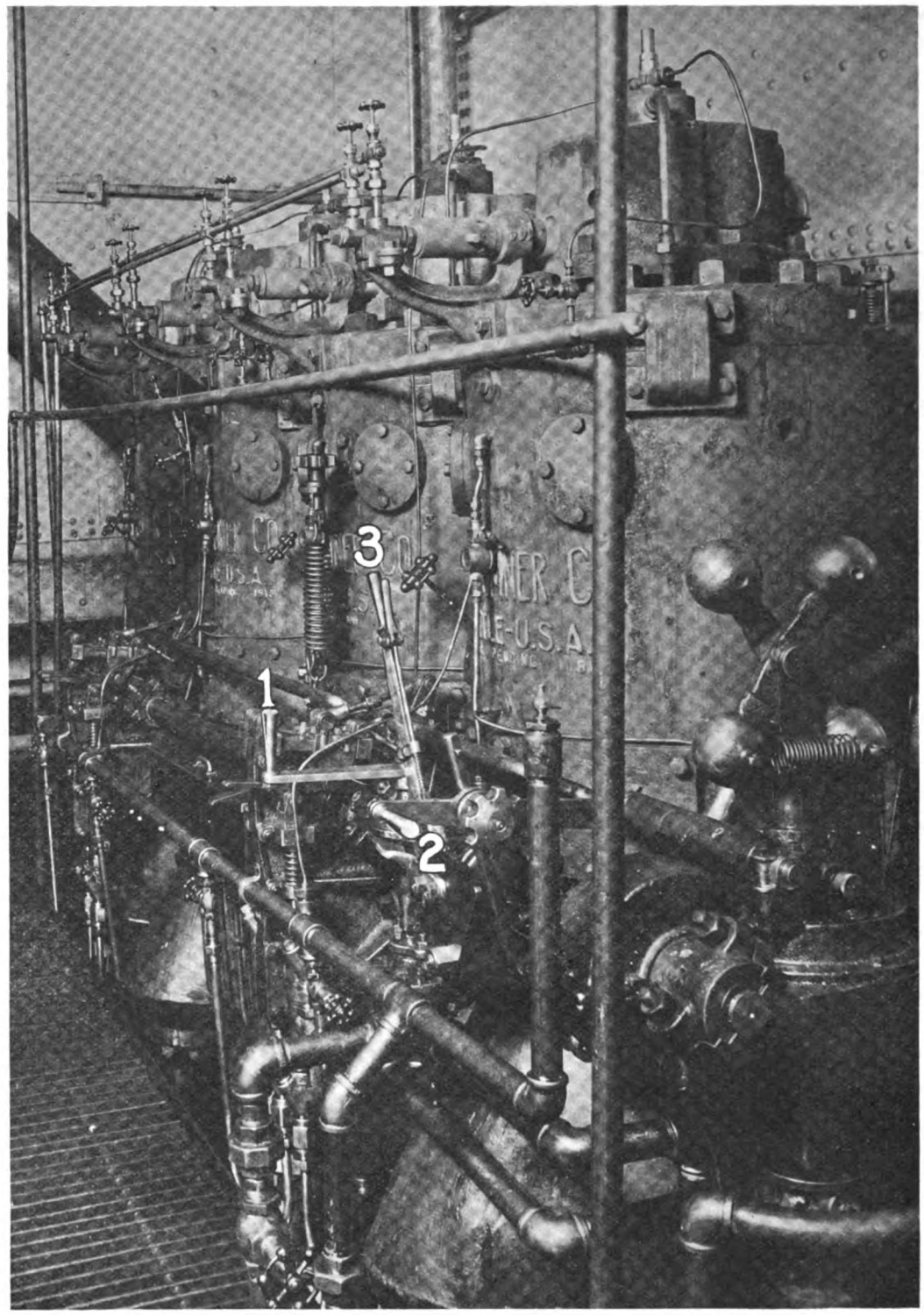
Ignition is of course through surface combustion chamber with compressed air torches which use fuel oil. This is an interesting feature as it makes it necessary to carry only one kind of fuel—heavy oil. The combustion chambers are fastened to machined surfaces on the cylinder heads by means of six studs, for quick removal. These combustion chambers are made of cast steel.

Lubrication is forced to the cylinders and with wick drop to all other bearings. Unions are fitted where necessary, so that the oil pipes may be taken down and cleaned. Each main crank pin is oiled by a cup carried on the connecting rod, taking oil from wicks overhead; the oil is carried to the crank pins by brass pipes secured to the connecting rods. These pipes have union joints where connected to the oil cups. Each main crosshead pin journal takes oil from an overhead wick cup. In general all the oil for the moving parts of the engine is supplied as far as possible from oil boxes, with wick tube and pipe. All working parts have oiling gear such as will permit of oiling without slowing.

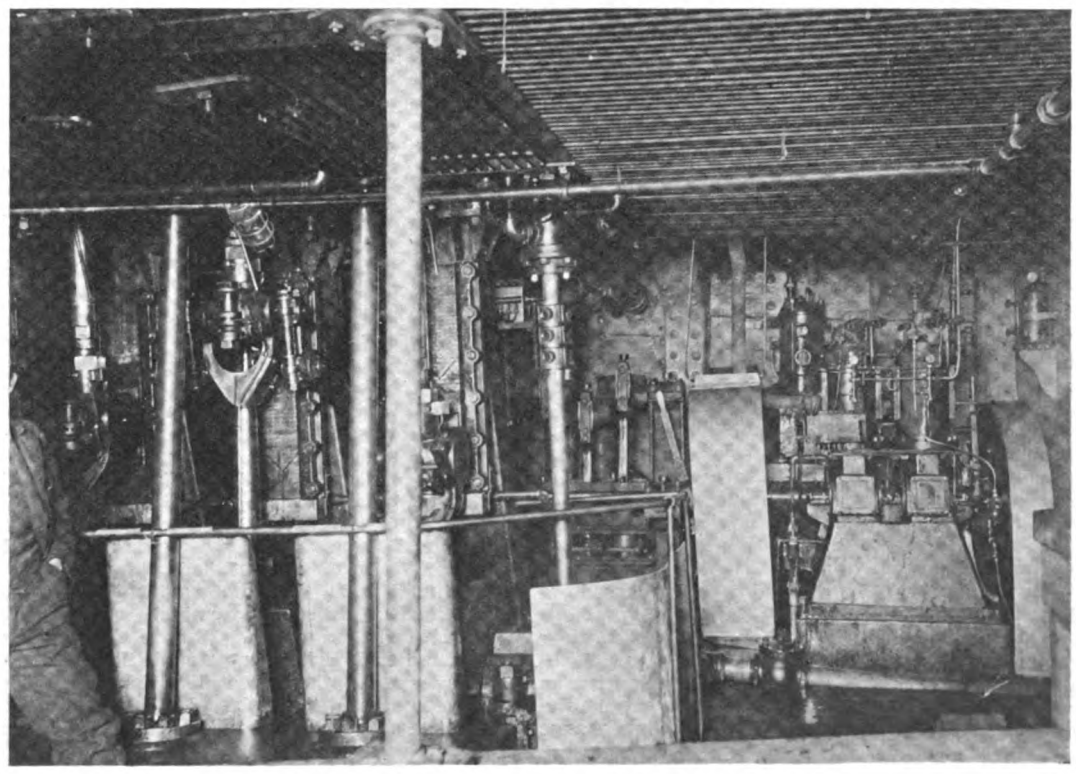
From the engine cooling water pump branches lead to the following bearings—the branches are of brass pipe: two pipes to each crank pin, three pipes to each thrust bearing, one pipe to each crank shaft bearing.

On the Sumner engine all auxiliaries, the scavenging pump, the air compressors, the water circulators, and the bilge pump are beam driven instead of eccentric driven, as enclosed types are. Beam drives are recognized by all ocean going engineers as the "Old Reliables." They do not run dry of oil quickly or stick and crack open like eccentrics, besides they are quiet.

The Sumner engine has a separate fuel in-



CYLINDERS, GOVERNOR AND CONTROLS OF PORT ENGINE.
(1) shows starting lever, (2) fuel control, (3) full injection timer.



FORWARD BASE OF PORT ENGINE, SHOWING AUXILIARY PLANT.

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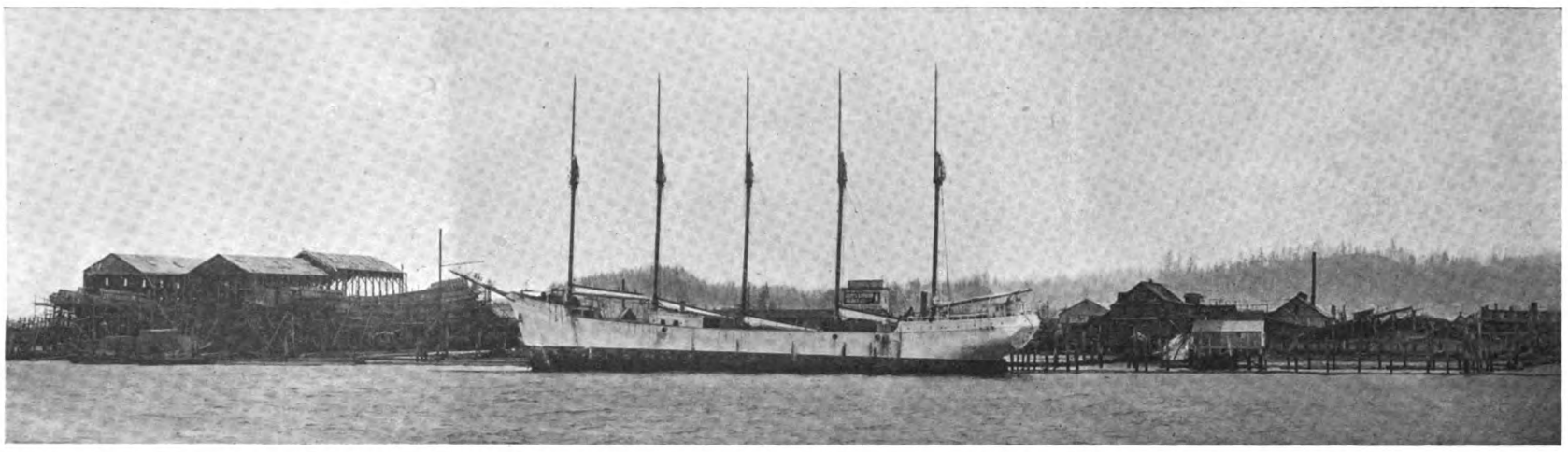

VIEW OF GRAYS HARBOR SHIPBUILDING CO.'S PLANT AT ABERDEEN, WASH. MOTOR SCHOONER "SANTINO" AT ANCHOR, THREE SISTER HULLS IN BACKGROUND.

jection pump driven by a cam for each cylinder. If any cylinder should have trouble, that cylinder can be located at once by simply holding down the pump levers, one at a time. This is analagous to the method used on some automobiles to find out which cylinder is not sparking properly.

The thrust block fitted to the Sumner engine is the horseshoe type which is universally used on ocean going steamers.

The thrust shaft is forged in one section. The shaft has 5 thrust collars. There is a coupling disc forged on the after end of such design that the tail shaft can be coupled into it with a nut and key similar to the fastening of the propeller to the tail shaft.

The shop tests of the first engine covered a period of approximately 10 weeks, during which indicator cards, consumption of fuel, pressure temperatures and combustion qualities were carefully recorded and then checked up with theoretical data and plans for verification. The horsepower was recorded on an electrical switchboard, the engine being connected to an electrical generator which discharged its current into a water rheostat. The maximum horsepower indicated by the engine was 550, and a maximum of 460 b. h. p. at the rated speed of 210 r. p. m.

The consumption per h. p. hour on test was 6/10 of 1 lb. and under. One of several desirable features is that the torches used for heating up heads prior to starting, use the same fuel as is burned inside of the cylinders.

The engines are positive in handling, starting, stopping and reversing, air from 60 to 200 lbs. pressure being used, and fed to each cylinder by a distributing valve which has position control of direction of rotation of the engine, incidentally the control is very flexible, being from 50 r. p. m. to maximum speed.

The factor that has received greatest consideration, with the exception of accessability of all bearings which can all be hand examined when engine is in operation, is the combustion. Additional scavenger pumps are part of equipment so that there is an excess of air for scavenging the cylinders of burnt gases of the previous charge and permitting a full cylinder of pure air for the combustion of the next charge.

Prior to leaving for the Atlantic coast via the Panama canal, the "Santino" was docked for painting. Three bladed wheels 6 ft. 6 in. dia. by 5 ft. pitch are used.

The engine installation was carried out by the Grays Harbor Shipbuilding Co. (the builders of the vessel) under the superintendance of F. E. Hogan, who also recently installed the twin Bolinder equipment in M. S. "Sierra."

A description of the "Santino," originally built for Swayne & Hoyt, and now owned by Gaston Williams & Wigmore, of New York, was given in a recent issue of Motorship and well deserved mention was made of the excellence of workmanship and material which the builders were putting into her. "Santino" is 290 feet over all, 48 feet beam and has a depth of 24 moulded. In rig she is a fore and aft, topmast, single decked schooner, and differs considerably in model from other aux. schooners under construction on the Pacific coast in her depth and deadrise. Her gross tonnage is stated as being 2,400 tons. She was loaded at the West Port Mill, Columbia river, 10th inst., with 2,200,000 feet of lumber, 1,000,000 of which is being carried on deck, this consignment being for New York.

H. W. Sumner, the designer of the Sumner engines, with which "Santino" is equipped, is making the trip accompanied by Mrs. Sumner for the purpose of watching the performance of his engines as far as New York.

FROM LEFT.—ALEX HYND, MARINE SUPERINTENDENT FOR GASTON, WILLIAMS AND WIGMORE; A. SCHUBACH, PRESIDENT GRAYS HARBOR SHIPBUILDING CO.; M. R. WARD, VICE-PRESIDENT, AND IN CHARGE OF CONSTRUCTION OF "SANTINO"; H. W. SUMNER, BUILDER OF THE ENGINES.

MOTORSHIPS FOR ELDER-DEMPSTER & CO.

In our February issue we announced that Harland & Wolff of Belfast had received an order for four Diesel-driven motorships each of 13,000 tons dead-weight-capacity, which are to be completed within two years. We are now enabled to announce that Elder-Dempster & Co. have placed an order with the same firm for three Diesel-driven motorships, each of 10,000 tons dead-weight-capacity, with a speed of 10½ to 11 knots.

THE BUILDERS OF "SANTINO."

The Grays Harbor Shipbuilding Co., of Aberdeen, Wash., appear to have been specially fortunate in their organization from the commencement of operations which barely dates back twelve months, the following gentlemen being responsible for the success attained: A. Schubach, president; M. R. Ward, vice-president; A. B. Shay, treasurer; Bruce Shorts, secretary. M. R. Ward, who has charge of the plant, was formerly associated with Ward & Sons, boat builders of Seattle, and although no vessels even approaching the dimensions of "Santino" were ever constructed at their old East Waterway yard, the ability of M. R. Ward to handle four such vessels in construction at once is conclusive proof of an old head on young shoulders.

The difficulties of organization, obtaining contracts, and basing prices at a time prior to the soaring of costs of material and labor, has been the downfall of many projected shipyards. The Grays Harbor Co., however, has, through excellent executive ability, escaped these pitfalls.

The selection and standardization of a type of vessel which would be a good lumber carrier and further answer the purpose of a general cargo carrier was another instance of long sightedness.

The selection and purchase of material, together with practical yard management in obtaining the maximum efficiency of plant and labor, has played another important part in the success of this company.

Shipbuilding today has become a national question and the ability, backed by patriotism, of such yards as the Grays Harbor will not be found lacking when it comes to a show down from Uncle Sam for ships and still more ships, first to aid our Allies over seas and afterwards enable us to enjoy our legitimate share of the world's commerce.

SKANDIAS SUCCESSFULLY TESTED.

The first two surface-ignition engines of 240 h. p. to be turned out at the newly-acquired manufacturing plant of the Skandia Pacific Oil Engine Co. on the Oakland Estuary have just been taken from the stand after undergoing a thorough testing. The tests were most satisfactory in every respect and there was not a little interest in them shown by the local trade. The engines were tested on California oil of asphalt base such as is largely used by motorships touching at this port. Two more engines of the same power and type as the first two are now on the testing stand. These latter will be used to power a vessel for Libby, McNeill & Libby. The first pair are for the new motorship "Margaret" of the A. O. Andersen Co., Astoria. About thirty more 240 h. p. Skandias are under construction and plans are under way for the building of some 350 h. p. engines, orders for which have already been booked. The new engines will be constructed complete at the one plant. The patterns are all made and the material has been bought. The first 350 h. p. engine to be built is for an auxiliary motor vessel under construction by the Petersen's shipyards at Grays Harbor, Washington. The structure adjoining the main plant of the company in Oakland, which building was formerly the Christopherson aeroplane shop, will shortly be converted into a department for building Skandias of the smaller sizes with horse power ranging from 5 to 80.

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Our Motorcraft Patrol Fleet

The Formation of a Naval Reserve for Submarine Chasing and General Police Duties—Ship Owners Can Do Their Little Bit!

(Special to Motorship.)

By T. ORCHARD LISLE

Washington, March 28th, 1917.

VERY few persons will realize the extremely difficult task the Navy Department has to cope with in endeavoring to form an efficient motorcraft patrol in the extremely short space of time before them. Hundreds of motorboats from 40 ft. to 150 ft. are urgently needed—some for policing sheltered waters, some for harbor and river services, some for carrying dispatches, others for inspection of coastal freight vessels five to fifty miles off shore, and finally,—the most important and arduous duty of all,—the scouting for and chasing of submarines twenty to five hundred miles out at sea in the Atlantic Ocean.

All sorts of suggestions are being hurled at the Naval officials at Washington—some excellent, others foolish—so the good have to be weeded from the bad. It is not merely the taking over of all motor-yachts and using them for the purpose, but many are the other more important considerations. To a very great extent motor-yachts will be used and for many purposes will be found most valuable, and all owners should loyally offer the services of themselves and of their boats, and, although very few yachts are substantially enough built or sufficiently seaworthy to stand months of hard driving at sea in the heaviest, as well as in the most placid, of weathers, good uses can be found for all moderately fast cabin boats of staunch construction.

Today I was enabled to have an extremely interesting conversation on the subject with Assistant Secretary of the Navy Franklin Roosevelt, who has the formation of the motorcraft naval reserve in hand, and who lucidly outlined the entire situation, showing that he has a concrete grasp of all the requirements.

Exigencies oblige the Navy Department to first direct all their energies on the Atlantic Coast, because it is there that protection from submarines is most likely to be needed in the near future, and certainly it is logical to believe that just at present we are not likely to fear submarine attacks on the Pacific Coast. The Navy Department has decided to order at once a large number of 110-footers, and these will be strong, seaworthy craft of special design, and capable of patrol work out at sea. When the Navy has sufficient boats for the Atlantic protection the Department doubtless will turn its attention to the Pacific Coast, particularly as the officials fully realize the possibilities of a necessity for a patrol off the Mexican Coast. At present the Department even doubts the advisability of having 110-footers built on the Pacific Coast for the Atlantic service, because of the long time required for delivery, and because of the great distance the boats would have to travel on their own bottom. If a number of gasoline engined boats made this journey of several thousand miles the machinery would need very considerable overhauling and repair after their arrival. Also there is much doubt if any could be completed before August 1st at the quickest, even if suitable engines can be found, and the engine question itself is one of the most serious the Navy has to tackle. For the most part the engines will be of the gasoline-using type, and will be furnished by the Department; but some boats will be built that will have different classes of machinery, and these, of course, will be more or less experimental, the urgency of quick delivery making these experiments unavoidable.

The total power of the engines required, I understand, will be about 750 b. h. p. in twin or triple screws, as the boats must be fast, consequently the weight must be reasonable, yet they must be sturdy enough to stand steady, continuous driving. All must be of the same size and power, as they will operate from bases in packs like hounds, and, of course, the speed of the pack is in accordance with its slowest unit, which will indicate the necessity of equal speed for all units.

Varying speeds will be one of the faults of the fleets of yachts that will be taken over, due to the great variance in design, size and power of individual boats. Exactly how many 110-footers will be built, and their speed, the Navy Department will not reveal. In appearance they will be not unlike a cross between the old Herreshoff Gloucester spoon-bow fishing boats and the Herreshoff Admiral's barges, with a good sheer, particularly forward of amidships, so should be very seaworthy and dry. However, I am inclined to consider that the deck at the bow should be filled out more than the design shows, thus giving more flare forward; also the forward sections should be a little fuller. This would ensure that they would be fairly dry in a choppy sea. However, perhaps this may best be decided after the first boat or boats have been placed in service, and any possible desired change with subsequent boats should not be a very difficult matter.

I presume, but do not know, that the Navy Department has information concerning the operations of the British patrol boats and of motor-yachts in the Royal Naval Motor Boat Reserve, to assist them in their plans and actions, in which case, many initial mistakes will be avoided. Of course, even if they are in possession of such knowledge it is not to be expected that the service will be ideal at the outset, as conditions differ vastly in this country; but no stone will be left unturned by the Navy Department to make the service thoroughly efficient.

As soon as the 110-footers are off the slips, some smaller craft, also of standardized design, will be built, and these will be engaged in naval police work in the various bays, rivers, harbors and sounds, along the Atlantic and Pacific coasts. All along these places rumors will arise, such as of enemy secret wireless stations; gun-running, depots, establishments of enemy submarine fuel, store, supply, and repair bases, enemy submarines taking shelter in scheduled waters, etc., and every one of such rumors will have to be thoroughly investigated by these motorcraft.

Mr. Roosevelt pointed out that an example of "police" work could be gleaned from the following: "He himself has observed that every day a number of small schooners come down into the Bay from the St. Croix river with loads of lumber bound for Boston, Providence, New York, etc. Now, it will be possible for traitors or enemy agents to charter or purchase such freight boats, and under the lumber carry fuel-oil, lubricating oil, water, ammunition and stores to enemy submarines waiting, say, fifty miles off shore, were these waters not thoroughly patrolled. It will be the work of 50, 60, 70, 80, and 90-footers to inspect or watch such coastal craft both by day and night, and in all kinds of weathers." In the event of meeting such a supply vessel it is very likely that there would be plenty of excitement for the crew and officers of the patrol boat. By judicious, and tactful operation they even may be able to track the submarine and sink her, thus making a double haul. Anyhow the work, while serious and severe, will not be so arduous, and monotonous, or such a strain upon the human system as will be weeks and months of waiting and watching for the submarines' periscopes three hundred miles out at sea in fog, rain, snow, storm and sunshine.

Bases will be established at various points along the coast from whence the various classes of fleets will operate and each base will be in charge of a competent engineer-officer, and there will be facilities for overhauling and repairing both the hulls and machinery. Generally speaking, when it is in full swing Uncle Sam's motorcraft patrol fleet will be the finest mercantile coastal navigation protector ever formed to meet unusual conditions of warfare on commerce. But the earnest co-operation of all shipowners and yachtsmen is immediately required and shipowners in particular should give or loan suitable boats to the Government; because it is their ships that are to be protected. Furthermore, many heavy craft will be required for mine-sweeping, and here again is an opportunity for shipowners to do their little bit by turning over suitable vessels to the authorities.

It was decided by Secretary of the Navy Daniels on April 9th that forty of the submarine chasers should be constructed on the Pacific coast, twenty-five at Bremerton and fifteen at Mare island. It seems altogether probable that these vessels will not be taken to the Atlantic coast, but will be permanently assigned to the two western naval bases.

When the bids were opened at Washington, D. C., on March 31st, it was found that there were 42 bidders, only one of which was from the Pacific coast. Plans and specifications were issued at such a late date by the navy department that it was impossible for the Pacific coast builders to get their bids to Washington.

Seattle, April 9th, 1917.

It was felt that inasmuch as the Pacific coast comprehended about 60 per cent of the wooden shipbuilding facilities of the United States and since speedy construction was the great desideratum that the western yards should be taken into consideration in the navy department's program. Motorship, therefore, called the attention of the Hon. Miles Poindexter, senator from Washington, to the facts in the case and as a result of Senator Poindexter's representations at the instance of Motorship special permission was secured to file bids in Seattle up until 7 a. m. of the day on which bids were opened at Washington.

This enabled western builders to submit figures or propositions to the government when they would not have been able otherwise to do so. Plans and specifications were not, however, made accessible at the Puget Sound navy yard until 1 p. m. on the day before the bids were to be opened so that scant opportunity was given to the builders to study what was at best a very difficult set of specifications.

As far as is known only two sets of plans came to Seattle for private builders, one to the Elliott Bay Yacht & Engine Co., the other to the National Shipbuilding Co.

The complexity of the specifications may be gleaned from the fact that bids for the construction of these 110-foot vessels, exclusive of engines, ranged all the way from $19,700 to $75,000, the lowest bid having been submitted by Charles J. Davis of Bridgeport, Conn., and the highest by John Wilson's Shipyard of Seattle.

With general reference to the bids opened at Washington it might be said that a number of builders, evidently appalled by the task of computing costs on the specifications furnished them offered to build the boats on a cost basis, the percentages of profit ranging from 8 to 20 per cent. The lowest Eastern bidders were the Defore Boat and Motor Works of Bay City, Mich., $20,250 to $21,750 per boat and Charles J. Davis, of Bridgeport, $19,500 to $21,000. The only Western bid filed in Washington was that of the Peninsula Shipbuilding Co., of $60,000. The bids run from $35,000 to $74,000 per boat, the majority of them being between $43,000 and $50,000. The $74,000 bid was made by the Mann Yacht company of Baltimore. The Portland bid is one of the four highest.

The various bids opened at Seattle were as follows:

Elliott Bay Yacht & Engine Co., 20 at $41,874,

A PATRIOTIC DUTY.

I RESPECTFULLY submit that it is the duty of all United States publications, and all loyal Americans, not to publish the details of any United States military plan or building operation, for these two reasons:

Firstly: Such publication furnishes information to the enemy.

Secondly: The people of the United States, almost all ignorant and grievously negligent of our military necessities, are being put to sleep and rendered apathetic by newspaper and magazine articles, expatiating upon, and exaggerating the value of, the mass of wooden submarine chasers, which may be of some little use; but the great mass of the public, in ignorance of the military necessity, are beginning to believe that, if the Government orders the submarine chasers the country will be perfectly safe.

Publications should give fair credit, without exaggerating what little military preparation is being made, and the press should devote itself and its striking headlines to pointing out to the people the great lack of military equipment, and the great additions that should be made. Very truly yours,

WALLACE DOWNEY.
Shipbuilder.

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the first boat in 60 days then one boat every sixth day; 30 boats at $39,781 to Jan. 1st, 1918.

National Shipbuilding Co., 50 boats in six months, ten in eight weeks, one every three days; 30 additional boats to Jan. 1, 1918; a total of 100 boats to Sept. 12, 1918, all at $30,000 each.

Wilson Shipyard, 5 boats at $75,000 each, delivery two months apart.

Scandinavian American Shipbuilding Co., 4 boats at $36,961, delivery in two, four, six and eight months.

Phinney & Brennan, 1 boat in four months at $37,000; 2 in five months at $36,000; 3 in six months at $35,000.

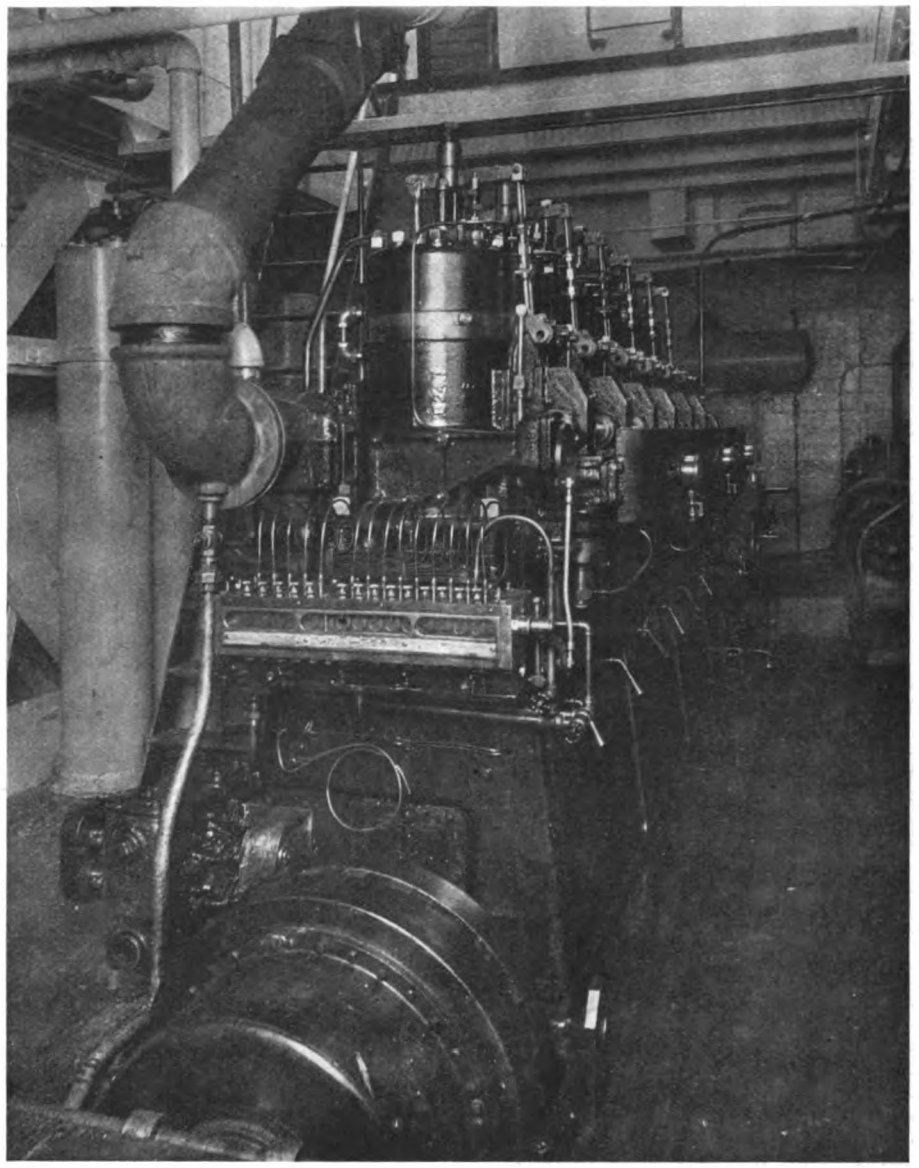
Portland Shipbuilding Co., hull only, 6 boats at $28,500, delivery at Bremerton two months apart, beginning three months hence.

E. B. Schock, the Guilder Supply Co., Western Shipbuilding Corporation, and Shertzer Bros. & Geary, cost plus 10 per cent.

The Navy Department has been subjected to some very severe criticism in connection with the call for bids on these vessels. One Eastern ship and engine builder, who has been one of the leading factors in the development of craft of this type, writes: "We are only tentative bidders on these boats because of lack of time and what we consider impossible specification." Similar comments are heard on all hands, some from large and responsible builders who were given no opportunity to submit figures.

Motorship does not subscribe to the theory that the Navy Department is sacrosanct. It believes it to be the duty of every technical journal to point out what is sincerely felt to be an error in judgment on the part of the department. In this case, however, we believe that any criticism should be tempered with an appreciation of the stupendous task which the bureau of construction faced. Under the circumstances the results were highly satisfactory.

The design represents a considerable advance over anything previously tried out and we have no doubt but that these vessels will prove highly satisfactory in service. On a number of occasions in the past we have expressed the opinion that a larger boat should be employed for this service than the standard 85-foot type built here for the allies and it is pleasing to note that the department is of the same opinion.

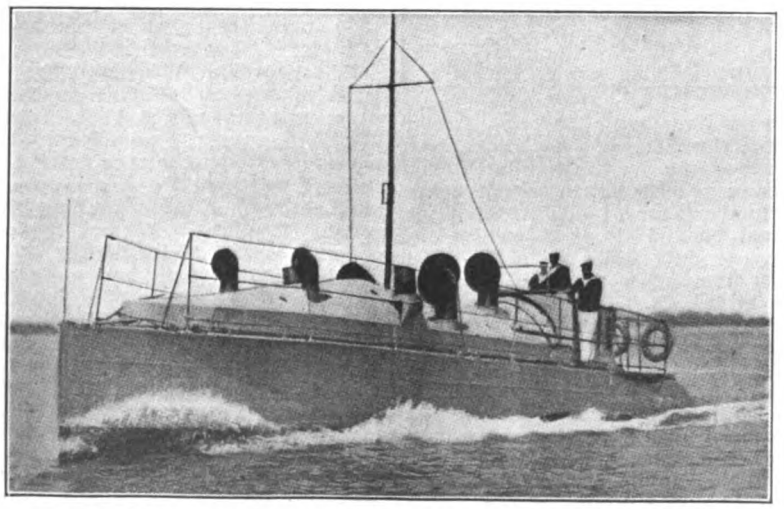


SOUTHWARK-HARRIS INSTALLATION IN FERRY BOAT "ROBERT BRIDGES," SHOWING SIGHT-FEED LUBRICATORS AND EXHAUST.

THE FIRST HIGH-SPEED SUBMARINE CHASER.

A Twelve-Year-Old Craft of 300 Horse Power.

APPARENTLY the original scheme for building a large fleet of motorboats for chasing submarines first was evolved by some bright person at the British Admiralty, for that navy took possession of their first boat of this class as long ago as 1905, and we give an illustration herewith. This patrol boat is named "Mercury II," and she is 60 feet long. Five Napier gasoline motors each of 60 h. p., a total of 300 b. h. p., drove her at 26 knots on the official naval trials, according to the navy records. She was a triple-screw boat built of steel by Yarrow & Co., Ltd., the British torpedo boat destroyer builders in 1905, or twelve years ago. After a period of idleness she resumed in 1910 active operations in connection with the British submarine flotilla. In the days when she was built high powered gasoline motors were not very reliable, and were very heavy, which accounts for five sets of moderate power being installed in the "Mercury II." Two pairs were coupled in tandem, and the fifth engine drove the center propeller shaft. Yet this speed of 26 knots (30 statute miles per hour) is 10 miles an hour faster than the 550 eighty-foot submarine chasers recently shipped from this country to England. In design she is quite a striking little craft and submarine chasers of today seem to show but little outward improvement in hull design.



"MERCURY II," FIRST HIGH-SPEED BRITISH SUBMARINE CHASER."

DESIGN MOST EFFICIENT PROPELLERS.

Improperly designed propellers cause great waste of power, loss of time and money. To remedy this the American Screw Propeller company, with offices at 505 Hale Bldg., Philadelphia, Pa., designs propellers according to the well known Dyson Method, and under Captain Dyson's personal supervision.

More accurate data (based on actual trial performances) is claimed by this company than is possessed by anyone else, and it is this fact together with Captain Dyson's personal connection with the company, which enables it to state that its designs and results obtained are the best possible obtainable today.

The American Screw Propeller company has published a little booklet containing a short history of the propeller, as well as the data necessary for designing the most efficient propellers. Marine engineers, naval architects and vessel owners will find this booklet most useful and interesting. It will be sent free of charge upon request.

This company has just moved to new and larger offices in the Hale building, due to their greatly increasing business.

THE BETHLEHEM STEEL CORPORATION.

We have on several occasions referred to the development of the marine Diesel engine by the Bethlehem Steel Corporation. We learn with much interest that all their various shipbuilding subsidiaries are to contribute to a common fund, each company doing its little share of experimenting and development, by which means they hope to produce a very fine engine. This certainly sounds excellent on the face of it, and would be a splendid step if it had been undertaken six years ago; but looking at it from a practical point of view, it would appear that they are doing just what the European companies did many years ago, so that in five years' time they may not have reached a stage more advanced than the European builders have arrived at today. Still, we all pay to learn!

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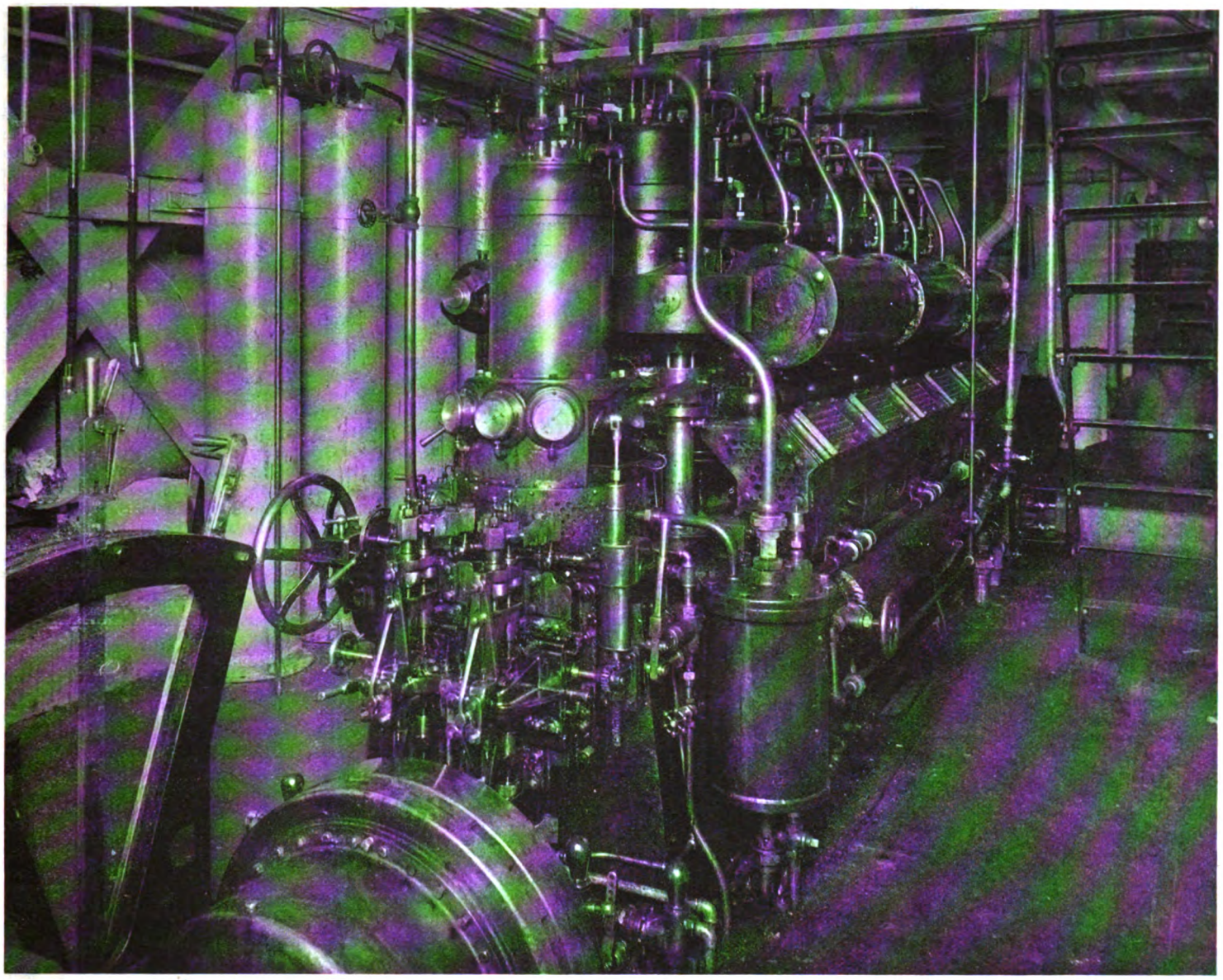
Diesel Engined Ferry "Robert Bridges"



SOUTHWARK-HARRIS INSTALLATION IN "ROBERT BRIDGES," SHOWING COMPRESSOR AND FUEL PUMPS.

The latest and one of the most interesting Diesel driven craft to be placed in commission on the Pacific coast is the ferry boat "Robert Bridges," which is operated by the Port of Seattle between the main waterfront of the city and West Seattle, across the harbor.

This boat recently completed at the yards of J. F. Duthie & Co., of Seattle, was designed by Lee & Brinton, Seattle naval architects, and a very good idea of her appearance and arrangement may be had from the accompanying illustrations. The vessel is of the double-ended ferry boat type, 100 ft. long, with a beam of 28 ft. and a depth of 10 ft. She is designed for passenger service only, with accommodations for 300, and her two decks will be completely given over to this purpose, there being cabins for both men and women on the main decks.

The scantlings used in the construction of the hull, meet the requirements of the American Bureau of Shipping. The stern posts and shaft logs are of oak. All other lumber in the hull is fir, treated with carbolinium. Floor timbers and frames are double and sawn from 5″ flitch, molded at the heel 10″ and at the deck 6″. The keel is 12″x12″, the clamps 4″ and the ceiling and planking 3″. There are four transverse bulkheads dividing the vessel into five water tight compartments. The hull is salted and care has been taken in the design so that all parts are well ventilated.

The cabins are well lighted from large sashes on the sides and from a skylight at the center running the full length of house. Life preservers are placed over the seats in the cabins and in chests on the deck. Companionways lead from each end of the deck house to the upper deck. All interior finish is simple and plain.

The vessel is propelled with a 6-cylinder 9″x13″ two-cycle Southwark-Harris Diesel engine, developing 225 brake horsepower at 300 r. p. m., which gives a speed of nearly 10 knots. The vessel is equipped with a 60x50 four bladed propeller at each end and shaft connected to the engine through friction clutches, but the stern wheel only is driven except when making a landing. This method was adopted on account of the large amount of drift wood usually afloat in the bay.

A two-cylinder San Francisco Standard gas engine of eight horsepower is installed as an auxiliary. To it is connected the auxiliary air compressor, the electric generator and the fire and bilge pumps. The fire lines will have three outlets, one at each end of the main deck and one on the upper deck about amidships. There is in addition to the fire pump two brass lined hand pumps which may be used either for fire purposes or for pumping out the bilge. For heating the boat in cold weather there is a small boiler using kerosene for fuel and supplying hot water radiators placed in the cabins, toilet rooms and pilot houses.

Electricity is used for lighting. The lamps are of the semi-direct type working under a pressure of 115 volts and supplied from a 3 kilowatt dynamo of the General Electric make. There is also a low-voltage system for use in case of accident to the main system. Current for this is supplied from an Edison storage battery under 6 volts pressure, this battery being wired in series with the main lamps so it will be kept constantly charged.

There are toilet rooms for each sex, water for the sanitary system being pumped from the sea to the supply tank by the bilge pump on the main engine. The toilets are of the syphon jet low pressure type fitted for salt water service.

It is interesting to note the great economy of this ferry as compared with steam. The distance across the bay is slightly less than two miles and the total time the engines will be working for the round trip should not be over 25 minutes. This oil engine will operate on about 12 gallons of oil an hour. With the price of oil at three cents per gallon, the trip across and back will cost 15 cents. The crew will consist of captain, engineer, and two deck hands. Later it is expected that the controls for the engine will be placed in the pilot house and the engine will be governed by the captain by means of compressed air. With this equipment one of the deck hands will be dispensed with and the cost of operation further decreased. Thus the saving as compared with steam is not only very marked in the matter of fuel, but also in the size of crew required for operation.

DIESEL FERRY "ROBERT BRIDGES."

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MOTORSHIP

A journal devoted exclusively to Commercial Motor Vessels and their operation. Issued on the 25th of each month.

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SUBMARINES AND MOTORSHIPS.

The almost complete immunity of motorships being sunk by submarines, that there has been, is due to the absence of smoke. A submarine lies low in the water, and its range of surface vision is very limited. Consequently the crew chiefly rely upon sighting the smoke of steamships during the daytime. A motorship half-a-dozen miles away is almost invisible to a submarine.

Furthermore, the great excess power that Diesel engines are capable of developing in times of emergency is a great factor in enabling a motorship to run away from a submarine when being chased. Some time ago the Atlantic Transport company's freight-carrying motorship "Mississippi" was pursued by a German U-boat. She is only a 11½ knot vessel; but, by cutting out the governor and by pumping over charges of fuel oil in the cylinders, her engineers were enabled to get 14 knots out of her, and succeessfully left the submarine astern. All the damage done by this heavy overload, was, we understand, a cracked cylinder. A steamer could not have increased her speed to such an extent and would have been caught and sunk.

SUCCESS EMANATES FROM MISTAKES.

There are certain shipowners who have abandoned coal-burning and oil-fired boilers and steam engines because of the splendid and economical service that they have obtained with heavy-oil engines. These owners have the warmest regard for this particular type of power after many years' sea-going experience. If more personal and discriminate probing was done by shipowners in general and less attention paid to rumors and hearsay, the marine oil engine as a commercial proposition would stand high in the estimation of all shipowners, instead of its great advantages only being appreciated by a limited number of owners. Taken on an average the results of all motorships in the world entitle the heavy-oil internal-combustion-motor to much wider appreciation and adoption.

Because about a dozen motorcraft, that have been brought into individualized limelight during the past five years, have proven far from satisfactory, there has been a tendency among many shipowners to treat lightly the use of the internal-combustion-engine for ocean-going ships, instead of giving the deep thought and discriminate consideration that it deserves and demands, and inquiring properly into the ulterior reasons thereof. Let it be remembered that it was partly this selfsame tendency to light treatment by some marine engineers, shipbuilders and shipowners that was the main original cause of the non-success of these particular unsuccessful motorships. Let it also be remembered that we always "pay to learn," and in paying for mistakes that emanated from boldness and enterprise in the earlier days many lessons of value have been learned. Today motorships are a proved commercial success, and this success largely is due to these past troubles having clearly revealed where the weaknesses lay, and have enabled these oil engine builders to produce machinery more reliable than steam.

EXPERIENCES OF CHIEF ENGINEER COLE.

Owing to Chief Engineer Cole having been obliged to sail for Europe before his article was completed, we shall be unable to publish the second part until our May issue.

RE ENGINES OF THE "MAUMEE."

Editor Motorship:

Referring to the very complete description of the Diesel engines in "The Naval Motor Tanker 'Maumee'" on page 16 in the February issue of "Motorship" by T. Orchard Lisle, I take it from the sectional view of Secundus' engine that the cylinder is made in two parts, the lower part which bolts to the frame and the upper part, the cylinder proper. Cn the upper dead centre of the crank, the piston just over-rides the lower part of the cylinder casting, while on the lower dead centre, a large portion of the piston has passed down into the bore of the lower part. I speak of this because the upper part of the cylinder of Secundus' is integral with the water-jacket and reboring of the cylinders would necessitate the boring also of the lower portion of the cylinder, unless it is intended to have the piston run free of the lower portion, fitting the upper part only.

The design of Secundus' engines is supposed to be an improvement on the "Maumee" engines, which are fitted with cylinder liners. I have always considered the cylinder liner, especially in a Diesel engine, an important improvement over the solid casting of cylinder and water jacket in one piece, and there must have been some good reason why in the engine of Secundus', the cylinder liner was abandoned.

It would be very interesting to know, and perhaps Mr. Lisle could furnish the information, what the ratio of displacement was between scavenging pumps and cylinders of the "Maumee's" engines. I understand that the pressure of the scavenging air was kept at about 7 pounds per square inch. The scavenging must be very perfect indeed to give a mean effective pressure in the power cylinders of 96 pounds per square inch. It would seem that at that pressure, the average fuel consumption would be below 0.5 pounds b. h. p. hour, but the mechanical efficiency being only 60 to 72% may account for it. I saw the "Maumee" engines in operation on the stand at the Navy Yard and except for the considerable noise of the cams and rollers operating the valve rocker arms, the engines operated very smoothly in either direction of rotation, the reversing being very prompt and easily manipulated.

Mr. Lisle, in his discussion, which really goes beyond the scope of the general oil-engine description, has certainly thrown considerable light on the design of large Diesel engines, which is no doubt, very welcome to all who are interested in this important industry and we look forward with great interest to the government report on the "Maumee" trial, which we hope will justify the expectations which have been placed in the performance of these engines.

Very truly yours,
WEISS ENGINE COMPANY,
CARL W. WEISS.

New York, March 15, 1917.

[Cylinder liner can be made permanently tight with four-cycle engines, but some Diesel engineers maintain that with a two-cycle engine the permanent tightness of a liner is doubtful, due to the orifices necessary for the exhaust parts. For the ratio of the displacement between the scavenging pumps and cylinders I suggest that Mr. C. W. Weiss write to Lieut. C. W. Nimitz of the M. S. "Maumee," as I have not these figures available.—T. O. L.]

NATIONAL SHIPBUILDING CO.

A recent issue of the New York Journal of Commerce contains a half page advertisement in the form of a prospectus issued by the above company of Seattle, Wash.

The initial offering is 100,000 shares of treasury stock at par $10 per share, capitalization $2,000,000 divided into 200,000 shares; 175,000 shares of treasury stock.

The property of the company consists of 11½ acres with extensive waterfront situated at Georgetown, Seattle, Wash. The present plant occupying a portion of this is to be greatly enlarged. The personnel of the company as set forth in the advertisement is as follows:

Officers and Directors—President, F. G. Fisher, Tacoma, Wash., capitalist; vice-president and general manager, Capt. O. D. Trieber, Seattle, Wash., naval architect and marine contractor; secretary and general counsel, George A. Lee, formerly first assistant attorney general, and chairman of the public service commission of the state of Washington; treasurer, Edward Meath, Tacoma, Wash., state treasurer state of Washington (1912-1916), vice-president Pacific Building and Loan Association. Reference—Any bank Seattle or Tacoma.

Operating Staff—Capt. O. D. Trieber, vice-president and general manager; Lloyd Johnson (designing and construction), formerly on the construction staff of the U. S. battleship "Nebraska" (built in Seattle); Dean Johnson, formerly superintendent Victoria Ship Yards, British Columbia; James McKay, assistant superintendent for twenty-five years in the employ of boat building concerns on Puget Sound; J. J. Jackson, yard foreman, formerly foreman Victoria Ship Yards, British Columbia.

Trustees—F. G. Fisher, Tacoma, capitalist. Reference—The National Bank of Tacoma; Judge W. W. Zent, Spokane, president Spokane County Bar Association and ex-judge of superior court, state of Washington. Reference—Any bank in Spokane; Edward Meath, Tacoma, Washington, state treasurer state of Washington (1912-1916), vice-president Pacific Building and Loan Association; Capt. O. D. Trieber, Seattle, Wash., naval architect and ship builder. Reference—The Scandinavian-American Bank, Seattle; George A. Lee, Seattle, Wash., vice-president and general counsel Northwestern Mutual Accident Association. Formerly first assistant attorney general and chairman Railroad and Public Service Commission, state of Washington. Reference—The Seattle National bank.

Advisory Committee—Charles Evan Fowler, member American Society Civil Engineers, author and authority on bridge and shipbuilding, etc.; Henry L. Gray, chief engineer Railroad and Public Service Commission, state of Washington, 1906 to 1913, appraisal and valuation engineer of Stone and Webster Public Utility properties in Seattle and the Northwest; L. E. Geary, naval architect and designer of "Sir Tom," yachtsman and designer.

A MOTORSHIP ENGINEER DESIRES POSITION.

Shipowners constantly advise us that they cannot get hold of motorship engineers. A certificated engineer, and with considerable motorship experience, who recently called upon our New York offices, is open for an engagement as engineer of a true Diesel-driven motor vessel. He is Mr. George A. Smith, 28 Caroline street, West Brighton, Staten Island, N. Y. Mr. Smith tells us that he has no desire to return to steam.

ANOTHER SHIP FOR MAHONEY.

Andrew Mahoney, who is already having two large motorships built at the yards of James Robertson at Benicia, and who has sold same to the Standard Oil Co., has just signed a contract for a third auxiliary schooner larger than the others. The cost of the new vessel will be over $200,000. Her length over all will be 270 feet; she will be 47 feet in the beam and have a depth of 23 feet. She will have five masts and the auxiliary power will be supplied by oil engines. The lumber for the vessel has been ordered in Oregon.

The Benicia Shipyards, better known as the Robertson yards, are rushed with work, with a crew of 150 men working on different vessels. New machinery has arrived to replace that which was damaged at the fire in the plant last month. This fire was caused by an exploding gas tank, so to obviate the possibility of a future fire of the kind three large electric motors are being installed to furnish power.

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Oil Engine Nomenclature

(Part III.)

By THOMAS ORCHARD LISLE

Opinions of Many Experts on What Constitutes the True Diesel Cycle.

A REVIEW of the opinions of the various Diesel experts as published in the March issue of Motorship showed that some of them have not fully grasped the proper and fundamental features of the true Diesel cycle because according to the law as laid down in several instances by them, the Hvid, Sabathé, Burnoil, Brons and Vickers designs all could be called Diesel motors, whereas they really are not.

Now that publicity has been given to the opinions of the Diesel engine builders it only is fair and reasonable that builders of surface-ignition motors (so-called semi-Diesel) should be afforded the opportunity to express their ideas on the subject, of what constitutes a semi-Diesel engine. Consequently I invited all the leading manufacturers of this class of machine to use the columns of Motorship for that express purpose. But, so far, only two makers have availed themselves of the invitation.

The first reply came from Mr. G. H. Jernberg, of the Marine Department of Fairbanks-Morse & Co., whose engine was fully described in our March issue. Mr. Jernberg says:

> "As to a definition of what constitutes a 'semi-Diesel' cycle, would say that we do not apply this term to our oil engines, and therefore we might refrain from a definition because we do not recognize the term.
>
> "Our catalogs covering both the marine and stationary of oil engines carefully avoid the use of the term 'semi-Diesel' because we do not believe that the term is correct, for the reason that it has no definite meaning. The term 'surface-ignition' is probably as good as any that could be applied to various engines in the hot-bulb, hot-disc and hot-tube classes, but for the reason that we do not, strictly speaking, use any of the above methods we do not care for the term.
>
> "In our catalog we state that our oil engine must not be confused with the hot-bulb or hot-ball engines because, while the combustion chamber is warmer than the cylinder its temperature is always a great deal lower than with the hot-ball or hot-bulb types. Ignition is effected by means of a combination of moderate compression and heat retained in the combustion chamber. As a matter of fact the combustion chamber of our oil engine is water-jacketed and of course this is not true of a hot-bulb engine.
>
> "We question if it is necessary to distinguish the oil engine by referring to its form of ignition. The term 'oil engine' may not as yet be distinctive enough for general purposes but in our opinion it will become so and be readily distinguished from the Diesel type by the absence of the word 'Diesel.'
>
> "It might be advantageous to refer to our engines as fuel-injection type, to distinguish them from four-cycle gasoline engines with kerosene adapters, which are sometimes called oil engines. For the present, however, we expect to call our engines 'oil engines', or more often 'heavy-duty oil engines', and we believe that the public will soon understand the type of oil engine referred to."

Next we will give the views of Mr. Carl A. Ross, of the Burnoil Engine Co., whose interesting motor was described in the January issue of Motorship. Mr. Ross remarks:

> "We have read with interest the article, 'Oil Engine Nomenclature', appearing in your issue of February Motorship and are glad of the opportunity to present our views on the matter.
>
> "The word, 'semi-Diesel' should literally mean, 'half-Diesel' or 'partially Diesel.' It is, in our opinion, a clever trade name only, but because of its broad use, the public now understand it to refer to the engines of the hot bulb class. To rob the hot bulb engines of their chosen name and to give it to a new type of engine would only serve, in our opinion, to cloud the issue still more. It would be fair neither to the manufacturers of hot-bulb engines nor to those manufacturers of the new type of engines on whom this name might be wished. The Burnoil Engine Co., is surely not asking for the right to use the name 'semi-Diesel' nor the name 'Diesel.' We do not want either. We believe oil can supersede steam as a standard of power in many fields as it has already done in Europe, consequently, we advocate that the words 'oil engine' should be boosted in all sale publications to attain and possess the same significance and standing that the words 'steam engine' have acquired. The term 'Watt engine' is now out of date and we hope to see the day when the words, 'Diesel' and 'semi-Diesel' will have only a trade mark value and the term 'oil engine' will mean something.
>
> "However, we recognize that in strictly technical publications not dependent upon sales propaganda and likely in strictly technical articles in some sales publications, the engineering fraternity may want to discuss the classifications of oil engines, but so-called popular articles on these subjects are bound to bewilder and discourage the buying public. We expect to adopt a registered trade mark for our engines but except for this we want our engine classified merely as 'oil engines'. There are technical reasons why we object to having the term 'semi-Diesel' applied to our engines as writers of past articles have advocated, and if these efforts continue, we shall ask for the opportunity to explain technically why this name is not appropriate for our engines."

So far no manufacturers (including those who contributed to the initial article) have said a good word for the use of the term 'semi-Diesel.' In fact they all condemn its use, which goes to show that in putting forward the term 'surface-ignition oil-engine' Motorship has hit the nail on the head.

Carl W. Weiss, Weiss Engine Co.: I think the term "Surface Ignition Oil Engine," which you suggest for all types of oil engines in which surface ignition is used, is perfectly logical, and I see no reason why it should not be accepted by all manufacturers of the type. From the engineering point of view, the term "Semi-Diesel" is not justified and really means nothing. I have always objected to it and I have never used it in my oil engines. The fact that the Diesel method was recognized immediately by all engineers as the limit in heat engines of the piston type no doubt tempted many manufacturers of low and medium compression oil engines to use the "Semi-Diesel" stamp to make it appear that their engines embodied some of the desirable features (such as self-ignition) of the Diesel engine without going to 500 pounds compression and 800 to 1,000 air pressure for the oil injection system. In other words, "Semi-Diesel" was considered a clever advertisement.

Following approximately Carnot's cycle, the air in the Diesel engine is brought to ignition temperature by mechanical compression only; then injecting the fuel in a finely divided state at the inner dead centre and graduated to the load—Constant Pressure Cycle—while Beau De Rochas originated the method of compressing a mixture of gas and air to ignition temperature, exploding it at the inner dead centre—Constant Volume Cycle.

All explosion engines known today are of the constant volume type, but only a few are of the self-ignition type. In this connection I must refer to an article which appeared in the February issue of Motorship, page 8, "A True Semi-Diesel Motor," which is also referred to in the article on page 11 of the same month, "Oil Engine Nomenclature" and I enclose a copy of one of my early patents, issued April 18th, 1905, No. 787709, in which you will note the fuel spray chamber communicating with the compression space by a very small spray hole. This is to my knowledge, the first arrangement showing a fuel chamber in connection with the compression space of the cylinder for the purpose of spraying the fuel into the compression space as the piston moves forward, whether the compression is carried to ignition temperature or not.

I built a number of these engines without the ignitor ball, using high pressure for self-ignition with fairly good success, but while these engines did well for kerosene, they soon developed trouble with the use of fuel oil. The Brons type of engine, which is claimed to be the original make, is along these lines. If I remember correctly, the first Brons motor was brought to this country by Mr. Tager in 1912. Mr. Tager was the Mietz & Weiss agent in Dutch Guiana at that time, and I understand he had a Brons machine here in New York on exhibition, which, however, I am sorry to say, I did not see in operation.

It might also interest you to know how the pioneer two-cycle (Mietz & Weiss) oil engine started its journey through all the countries of Europe. The great number of manufacturers of this type of engine in Europe, as well as the United States, is sufficient proof of its general and very favorable reception.

My first two-cycle oil engine was made in 1895. At that time there was no two-cycle engine of this type on the market here, nor in Europe. The two-cycle engine was pretty well known, but as an oil engine along the lines designed, it was the first. The first few years we built a great many of these sizes, from 2½ to 8 h. p.

In the first article on the subject in the February issue a slight slip of the pen occurred. In describing the surface-ignition type of oil engine I mention that there was an exhaust-heated bulb. This, of course, should have read "combustion-heated bulb."

"ELSE" HOMEWARD BOUND.

The schooner "Else," built by Babare Bros, Tacoma, 1916, and owned by the A. O. Anderson Co., sailed from Port Pirie, Australia, February 28th for San Francisco. On arrival she will receive her auxiliary set of Bolinder oil engines.

PENINSULAR SHIPBUILDING COMPANY SELLS MOTORSHIPS.

It is reported that the auxiliary schooners "Alpha" and "Beta," under construction by the above company at Portland, Ore., have been sold to Bowman Bros. of New York.

The "Alpha" was launched several weeks past and the "Beta" is still on the ways. Both vessels are to be equipped with Winton Diesels.

"COLUMBIA RIVER" MAKES FAST VOYAGE.

The schooner "Columbia River," built by Capt. Peterson of the Aberdeen Ship Yard, Washington, for Balfour, Guthrie & Co. during 1916, is making a fine record on her maiden voyage under canvas alone. She arrived at Newcastle, New South Wales, from Port Pirie on the 16th of March, making the fast time of 188 days. At Newcastle she loaded for the West Coast and upon her arrival at San Francisco will receive her power plant, consisting of a twin set of Bolinder oil engines supplied by Henry Lund & Co., West Coast representatives.

ROLPH CO. BUYS SHIPYARDS.

The Rolph Coal & Navigation Co., of San Francisco, the head of which is James Rolph, Jr., mayor of the city, has just concluded the purchase of the H. D. Bendixson shipyards at Eureka, Cal. Mr. Rolph in person negotiated the transfer, visiting the plant in the north. He also acquired sufficient property adjacent the yards to give the plant a water frontage of 2,000 feet. The purchasing company will take possession as soon as two vessels now on the ways have been completed. The capacity of the plant is to be greatly increased. Arrangements have been made whereby the Northwestern Pacific railroad has agreed to extend its tracks along the peninsula to the yards. The amount of money involved in the transfer has not been announced.

MOTOR MANUFACTURERS!

Engineering concern of proved selling ability desires connection with manufacturers of internal combustion motors who are doing high-grade work. Financial assistance for further development or expansion can be given if conditions justify. Please write. X-36, care Motorship.

DE LA VERGNE TO ENTER MARINE FIELD.

The De La Vergne company, of New York City, the well-known stationary oil engine manufacturers, have decided to enter the marine engine business without further delay. Their marine engine will be of the four-cycle surface-ignition type, in fact, will be a modern development of the old Hornsby-Ackroyd motor, of which they purchased many years ago the sole American rights. The sizes produced will be up to 1,000 horsepower.

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Famous Sailing Craft to Get Diesel Type Engine

By Perry Young.

AUXILIARY BARK, "EDWARD SEWALL."

WHEN, on Dec. 12, Captain "Bob" Quick ran up the houseflag of the Texas Company on the maintopmast of the ship "Edward Sewall," he foresounded the death-knell of the good boat as a clipper. During the seventeen years since she was launched in 1899, Captain Quick has sailed her over the seven seas. In her he has raised to young womanhood two pretty daughters, and those who know the boat declare that the home quarters in her after end are the most beautifully and comfortably appointed of anything that sails the seas. In her he has made many a passage pay the worth of the boat for the owners. Five thousand miles he has sailed her from Shanghai to Puget Sound in 22 days; 2,260 miles from Puget Sound to Honolulu in 12 days, and 2,080 miles from San Francisco to Honolulu in 10 days, though she was never a speed boat.

But the Sewall has been sold to the Texas Company which will use her in the oil trade, and next spring is to be fitted with a brace of Southwark-Harris oil engines, of the Diesel type. The big engines will be 24 feet on the bed, by 8 feet wide, by 16 feet high, and are to be furnished by the Southwark Machine and Foundry Company of Philadelphia.

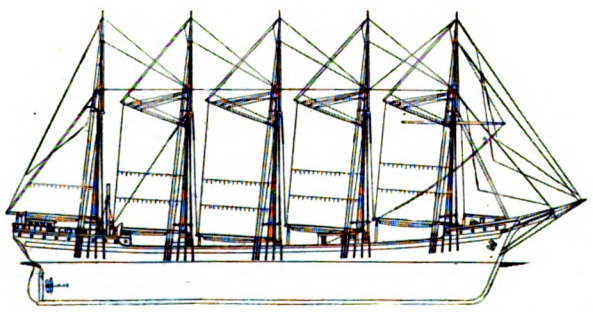
With the change of the "Edward Sewall" from a wind- to a motor-driven vessel, there passes from the sea the last remaining example of the ideals of the late Arthur Sewall. This man, who was W. J. Bryan's running mate in the latter's first race for the presidency, was an idealist and believed that the sailing ship was the instrument which would restore to America the former glory of its merchant marine. Faithful to his convictions he built the "E. M. Phelps," the "Edward Sewall," the "Arthur Sewall," the "William P. Frye" and the "Kineo." The "Frye" was sunk by the "Prinz Eitel Frederich," and of the others the "Edward Sewall" alone remains with only canvas to propel her.

The boat carries 37 pieces of canvas, aggregating 13,000 square yards of sail, the spanker, ringtail and gaff-topsail on the jigger, three staysails between the jigger and the mizzen and four between the other masts; and the foremast, main and mizzen carry everything from main yards to a royal, including double topsails and double topgallants. Her net register is 2,916 tons. She is 332 feet long, 45 beam and 25 depth and was built at Bath, Me., in 1899.

PAMPHLET ON DOUGLAS FIR SHIPBUILDING

Through the courtesy of the Peninsula Shipbuilding company we are in receipt of a brochure entitled "Douglas Fir Shipbuilding," by Howard B. Oakleaf, in charge of the office of Forest Products, United States Forest Service, Portland, Ore. This excellent little work, a reprint from a previous article by Mr. Oakley, deals with the mechanical and physical properties of Douglas fir (Oregon pine) in a thorough way which even seasoned builders will find of interest and profit. Copies may be obtained upon application to the Peninsula Shipbuilding Co., Portland, Ore., which concern is to be commended for its enterprise in making Mr. Oakleaf's article available for general distribution.

WOODEN VESSELS



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OLYMPIA WASH.

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Shipping Board Investigates Pacific Coast Facilities

A large and representative meeting of Pacific coast designers, shipbuilders, shipowners, lumbermen, shippers and engine builders was held under the auspices of the Seattle Chamber of Commerce April 4 for the purpose of placing before the Hon. Theodore Brent, vice-president of the United States Shipping Board, all available data respecting shipbuilding and shipping on the Pacific coast first hand.

Mr. Brent made it very clear to all present just what the aims of the Shipping Board were and what he desired to learn was **what in the opinion of the Pacific coast builders was the most suitable type of wooden ship to build and just how many could be built in a reasonably short space of time.**

The United States Shipping Board will finance the building of a large fleet of ships to the tune of $15,000,000 within the next few weeks. These vessels when completed will be leased to private interests, every effort being made to avoid opposition with existing shipowning companies which operate regular freight services.

A representative of the Shipping Board has visited every shipbuilding center on both coasts of the American continent, Mr. Brent completing his western seaboard tour in Seattle. The valuable and convincing data of comparison between steam and Diesel driven vessels, which Motorship has continually offered the shipping world since this journal came into being, has most apparently taken root in the minds of the intelligent and far-seeing, and that the steam propelled vessel was out of consideration being the opinion of the practical Pacific coast builders is encouraging to us in our efforts. There may still be a difference of opinion as to the desirability of type, but economically it is in favor of the straight motorship as against the auxiliary.

How large a motorship, in wood, therefore can we build and engine?

Several opinions were expressed by practical designers and some sound arguments were put forward in favor of keeping within limitations to avoid the use of steel reinforcements which a soft wood ship would require if built in lengths of 300 feet or slightly over.

That good serviceable Diesel engines can be built in America in units sufficiently large for a full powered vessel suitable in size and character for the requirements of the shipping board is also an established fact, but in what quantities can these be turned out?

Here is the well earned opportunity of the pioneers in the heavy marine oil engine industry, and they will surely receive their reward should as is likely the Board select a few proven Diesels and surface ignition types arranging for their manufacture in large numbers by factories throughout the United States.

As to the proportions of the hull which the Shipping Board decides upon, this is the least of our worries as they now know the safe limitations of the dimensions of such a vessel as they require. What concerns us is the building! The material is procurable, but the labor is the vital question, and as in the past, our wooden ship yards will be a training school for some time to come for ship carpenters. That house carpenters can be quickly taught the trade under the direction of a good shipwright is, after all, something to be thankful for. With standard ship construction half the battle is won however, as the templates and spilings will be the same for each vessel, and the yard foreman will just have to get his coat off and sail in with the rest of the crew.

The following is a transcript of the meetings held both in Portland, Oregon, and Seattle, Wash. Portland, April 2:

H. E. Pennell opened the meeting held under the auspices of the Portland Chamber of Commerce, when the Hon. Theodore Brent, vice-president of the United States Shipping Board, and J. Y. Underwood, naval architect, accompanying him, were introduced.

Daniel Kern—I think that ships can be built here without any great difficulty. The greatest drawback will be labor. There might be difficulty in obtaining chains; hoists and machinery are built here, cargo winches are built here. Skilled labor is not very plentiful. Tools available. A great deal of unskilled labor could be used.

Mr. Brent—Do the labor organization rules interfere?

Daniel Kern—They do not interfere.

Question—Do the unions lay down any rules regarding unskilled labor working with skilled labor?

Answer—There has been no trouble made.

Question—Has the wage raised very much?

Answer—$4 to $5 for ship carpenters.

Question—What is the maximum size of cargo carrier that can be successfully developed from the timber you use here?

Answer—A 4,000-ton vessel without any trouble.

Question—What are the outside dimensions of a ship of that kind?

Answer—About 300 feet in length, 45 feet beam, 24 feet depth of hold.

Question—What is the life of a ship of that size?

Answer—25 to 30 years. Vessels built 19 years ago still in commission.

Mr. Brent—It is desirable that we undertake to build to our own standards. I commend it to your consideration. One of the things that the Shipping Board has in mind is to adopt standards that shall be American standards. If we are to have a merchant marine, we must adopt standards of our own building.

Mr. Joseph Supple—Mr. Ballin has designed a ship which I think is right; 4,000 tons d. w. capacity. Run an open shop and employ 200 men on one ship. Have ways for four ships now, could expand to twelve easily.

Mr. Heath—After plans have been made for one ship we might as well start eight or ten, do not anticipate trouble with labor unions. The men employed are mostly Norwegians and Swedes. Unskilled labor could very easily be put to use if the men have ability.

Mr. McCormack. (St. Helens Shipbuilding Co.)—A few years ago 200 feet long was the biggest vessel built of wood, much larger now, 300ft. in length, keelson reinforced with steel.

Mr. H. E. Pennell—We can build up to 300 feet in length without adding steel re-inforcements or strapping.

Mr. Lang (representing English Lloyds)—I am not of the opinion that ships of over 270 feet should be built of all wood. I think they should be re-inforced.

Mr. N. T. Palmer—I have just seen a blue print from New York of a wooden vessel 300 feet long built over fifteen years past entirely of Oregon and Washington wood. Since then six masters have been built over 300 feet in length, many such vessels carry 5,000 to 5,500 tons. No steel strapping used until they reach 290 feet on the keel.

Fred Ballin, (Naval Architect)—I prepared a plan for a 4,000 ton ship, which I submitted to British Lloyds, American Record. and other societies. It has been classed in the highest classification that can be awarded. I am building two of those ships here now 308 feet long, 285 feet keel, internal combustion engines, dead weight capacity 4,300 tons not including fuel. These ships will have 2,500 barrel oil tanks, full Diesel engines, radius of 12,000 miles. I also have the plans of a 5,000 ton wooden ship approved by Lloyds.

Capt. Richard Chilcott—Speaking of diagonal strapping you can fasten to oak but you cannot strap to cross grained fir. I have designed a wooden vessel 283 feet long, 44 feet beam, 24 feet depth of hold, which will carry 4,350 tons.

Meeting held at Seattle April 4, 1917, under auspices of Chamber of Commerce and Commercial Club.

Mr. Joseph A. Sloan, (Designer)—In my opinion it is not wise at this time to take up wooden shipbuilding on this coast to exceed thirty-six hundred tons, in all round dimensions, of about 280 to 285 feet in length, 46 to 46½ feet beam, 25½-26½ feet moulded depth. I am not stating that because I don't believe vessels can be built of wood to a much larger size, but at this time, in my opinion, it is not advisable to do so, because to build larger ships of larger tonnage it will necessitate, in my opinion, the use of a great deal of steel for reinforcing these ships, steel at this time being very hard to obtain and very costly. The type of ship for the Atlantic coast and war zones, in my opinion, should be a motor or steamship carrying from three thousand to thirty-six hundred tons, and a speed of about ten knots per hour.

Mr. Brent—What horsepower would you give a vessel of that kind?

Mr. Sloan—From thirteen to fifteen hundred horsepower. The price I should put roughly at $100 per ton, a 3,600 ton ship at $360,000 complete.

Mr. Brent—Ships as you would build would have a rating of A-1, would they?

Mr. Sloan—Yes, and I would like to state that if the United States is going to build ships, they ought to be classed by an American bureau of classification. (Applause.)

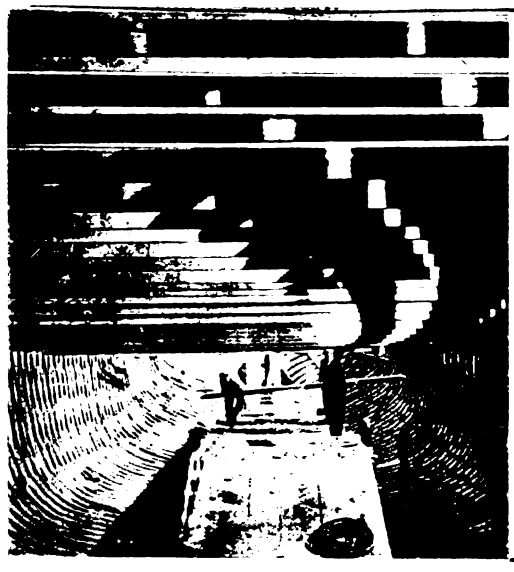
Mr. Schock, (Naval Architect)—What the Board wants, as I understand it, are vessels for general cargo carrying.

Mr. Brent—Yes.

Mr. Schock—A vessel of from three thousand to thirty-five hundred tons could be constructed of about 265 to 275 feet in length and about 40 feet 6 inches beam with two or possibly three decks. A vessel of these dimensions could be equipped with Diesel engines and have a cruising radius of about ten thousand miles. The deadweight capacity would not be less than three thousand tons.

Mr. Erismann, (Naval Architect)—As far as the size of ships contemplated, between three and four thousand tons, such ships will have to be strapped and you will also have to put two and three decks in them.

Mr. Brent—You do not disagree with the idea



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of a ship of three to four thousand tons carrying capacity?

Mr. Erismann—No, providing you eliminate the sails and make her a full powered vessel.

Mr. Heffernan, (boiler and steam engine builder)—The steam plant would hardly be practicable for any great distance if you undertook to put in a big horsepower in one of those wooden vessels, you would use up too much space. It is hard to get boiler tubes and boiler plate today. In regard to auxiliary engines, there is no question about you being able to get engines of the semi-Diesel (surface-ignition) type. There are a great many shops right here in Seattle fitted up with good equipment, organization and good mechanics. They can take and specialize on some one type of oil engine that has already proven a success.

Mr. Brent—What have you in mind?

Mr. Heffernan—Well, take for instance the Bolinder engine, that is an engine which has been tested out.

Mr. Eugene R. Ward, (President of the Olympia Shipbuilding Co., Olympia, Wash.)—We are building a 3,500 ton vessel, have three under construction the same as my brother is building (Grays Harbor Shipbuilding Co., Aberdeen). They have two arch straps each side. There is 20 tons of strapping in each vessel. We work open shop and 50 per cent of our labor is skilled. Could without doubt double my labor.

Mr. Brent—And what character of engines are you putting into the vessels?

Mr. Ward—We are building engines locally right in Seattle. A semi-Diesel (surface ignition) 350 horsepower four cylinder (Sumner oil engine). She carries 1,500 barrels of fuel with room for at least 500 additional. The first ship of this type tried out (The "Santino") makes between seven and eight knots and not under favorable conditions.

Mr. Brent—Have you been able to get delivery of engines?

Mr. Ward—Yes.

Mr. E. G. Winter—I am one of the firm of the Skandia Engineering company, who are manufacturing in San Francisco. We have permission from our factory to quote you a delivery of eight 240 horsepower engines per month, and two 500 b. h. p. per month commencing five months from now.

Mr. Brent—What is the largest you build?

Mr. Winter—500 horsepower.

Mr. Brent—You usually use two in a vessel?

Mr. Winter—Yes, twin screw installation, and I believe factories could be opened in different parts of the country to build on a royalty. These engines have been operating the world over for the past 18 years.

Mr. Brent—You are able to find the proper men to handle them?

Mr. Winter—Yes, it takes very little time to break in a man with a mechanical bent.

Mr. Fox, (Secretary Washington Shipping Corporation)—I am requested to make a statement for the agents of the Meitz and Weiss engines, of New York. The Washington Shipping Corporation has ordered a number of these engines, their technical man being engaged today in installing a set in our first vessel. We ourselves are figuring today on having some engines built here, Meitz and Weiss have wired that they can turn out eight pair of 320 h. p. per month in their old factory and the same number in a new factory which they are building in New York.

Mr. Brent—Do they build larger engines?

Mr. Fox—Yes, up to 600 h. p.

NATIONAL SHIPBUILDING COMPANY CLOSES CONTRACT.

The National Shipbuilding company, of Seattle, Wash., have laid the keel for a motorship of the following dimensions: Length over all 150 feet, beam 36 feet, depth of hold 14 feet, which is being built to the order of Messrs. Wakefield & Co., of the Apex cannery, who will use this vessel in the Alaska freight trade. The power equipment will consist of a 300 b. h. p. Atlas true Diesel. The contract calls for the record delivery of the vessel in ninety days. The cost is reported as being $100,000.

SEATTLE PLANT ADDS FACTORY TO BUILD OIL ENGINES.

After months of experimental work with a surface ignition engine of the marine type and in answer to the demand being created by the United States Shipping Board for marine oil engines, the Seattle Machine Works make the authorized announcement, as we go to press, that they will at once construct a separate and complete factory exclusively devoted to the manufacture of heavy oil engines for marine purposes. Small sizes will be built from 75 h. p. for fish boats and cannery tenders, whilst 300 and 400 b. h. p. units will be constructed in large quantities for ocean going auxiliaries and motorships.

The site chosen for the new factory are lots 4 and 5 on the Duwamish waterway, Seattle, which has a water-frontage of 900 feet and a total area of three acres. The first building erected will be 75x200 feet.

Dredging is now in operation to provide deep

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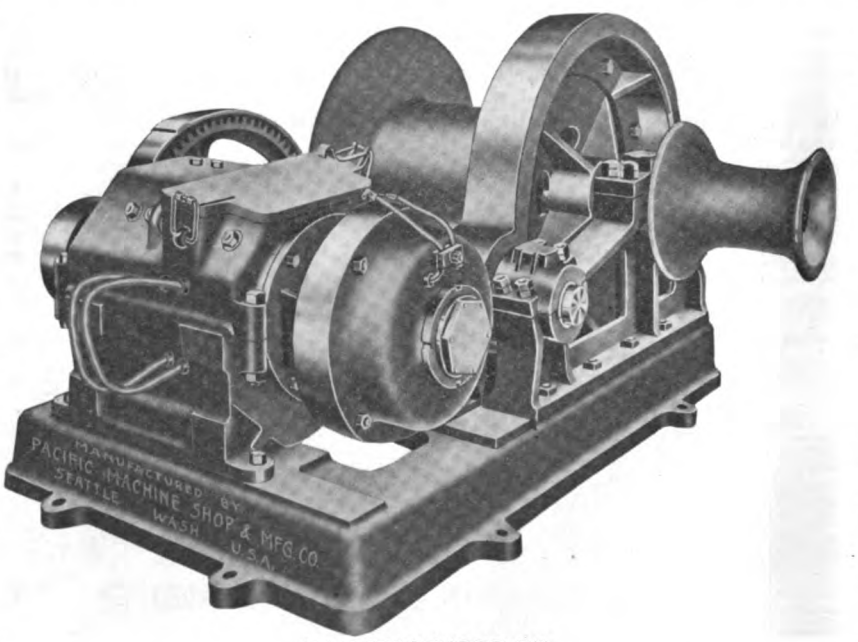

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SHIPBUILDERS LUMBER CO.

An announcement of considerable importance to both projected and established shipbuilding companies is that of Messrs. R. W. De Weese and J. S. Long, who under the title of the Shipbuilders Lumber Co., will in future specialize in lumber for the shipbuilding trade.

During the past eight months and prior to the incorporation of this company six million feet of lumber has been placed with Seattle ship yards by R. W. De Weese, who for the past fifteen years has been engaged in the lumber business on the Pacific coast. J. S. Long, who will act as secretary to the company is president of the Long Building Co., of Seattle, and has a long record in the construction and manufacturing trades. The advantages to be gained through business connections with such a firm as the Shipbuilders Lumber Co. are at once apparent, especially when prices of vessels today are based upon time of delivery more than actual cost.

By a careful selection of and arrangements made with a number of mills which can procure and handle lumber of all sizes and grades suitable for shipbuilding, such as framing, planking, decking and finishing, as well as spars and ships knees, without a limit to the supply and immediate shipments offered, the Shipbuilders Lumber Co. can save the shipbuilder no end of time and expense, both in getting out his estimates and completing the vessel within the contract period. That the success of such a company offering a service which is so badly needed is assured, goes without saying. The offices of the Shipbuilders Lumber Co. are located in the Leary building, Seattle. Their advertisement appears in this issue giving further particulars.

LUMMI ISLAND NAVIGATION CO.

The miniature passenger and freight boat now being constructed at Lummi Island for the above company is just about completed. This interesting craft from the boards of L. E. Coolidge, Seattle naval architect, is well worth describing, as she is about the biggest little ship we have run across. On an overall length of 65 feet a generous beam of 20 feet has been given her, yet she is not boxey or sawed off; in fact her cross-sections and water lines are exceedingly sweet with considerable hollow, of course, in the latter forward. She will pack a large amount of freight and provides comfortable day accommodations for passengers, exclusive of living quarters for crew. Her power plant, now installed, consists of a 75 h. p. C. O. type Fairbanks-Morse oil engine, similar engines now giving excellent results in "Aloha" and other vessels.

REPAIR COSTS OF A MOTORSHIP.

We have before us a statement signed by the chief engineer of Hamburg, of the Hamburg-American line, and apparently made at the instance of Herr Ballin, the director-general, to the effect that the repair bill of both the main Diesel engines and the auxiliary Diesel machinery of the 2,500 i. h. p. motorship "Christian X," a freighter of 10,075 tons displacement and 7,200 tons d. w. c., owned by them, amounted to $5,200 per annum when 250 days at sea and 115 days in harbor. These figures compare very favorably with the repair bill of a steamer of similar size. The operating period of this ship was from July 22, 1912, to May 22, 1914, during which 66,360 sea miles were covered. Since the war, of course, she has not been seen in the Atlantic service.

During conversations with ship owners they frequently have brought up this vessel as an argument against motorships, mentioning all sorts of bad reports that they had heard. The publication of these figures will do much to disperse evil rumors. Had the ship been laid up for lengthy periods she could not have covered nearly seventy thousand nautical miles during the short time she was in service. This reminds us that she was purchased at a moment's notice from the East Asiatic Co. When on her trials she entered Kiel harbor, and Kaiser Wilhelm and Herr Ballin went abroad. The next day the transfer transaction was completed. Was the Kaiser responsible?

GRAY ENGINE FOR "TRANSIT."

The steam tugboat "Transit," formerly owned by the Union Oil Co., is having her steam power removed and modern surface ignition engine equipment installed instead. The engine to be put in is a Gray (San Francisco) 160 h. p., 4-cylinder, made at the United Iron Works.

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